High-Tension Switching and Fusing

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The Journal of ELECTRICITY POWER AND GAS

DEVOTED TO THE CONVERSION, TRANSMISSION AND DISTRIBUTION OF ENERGY.

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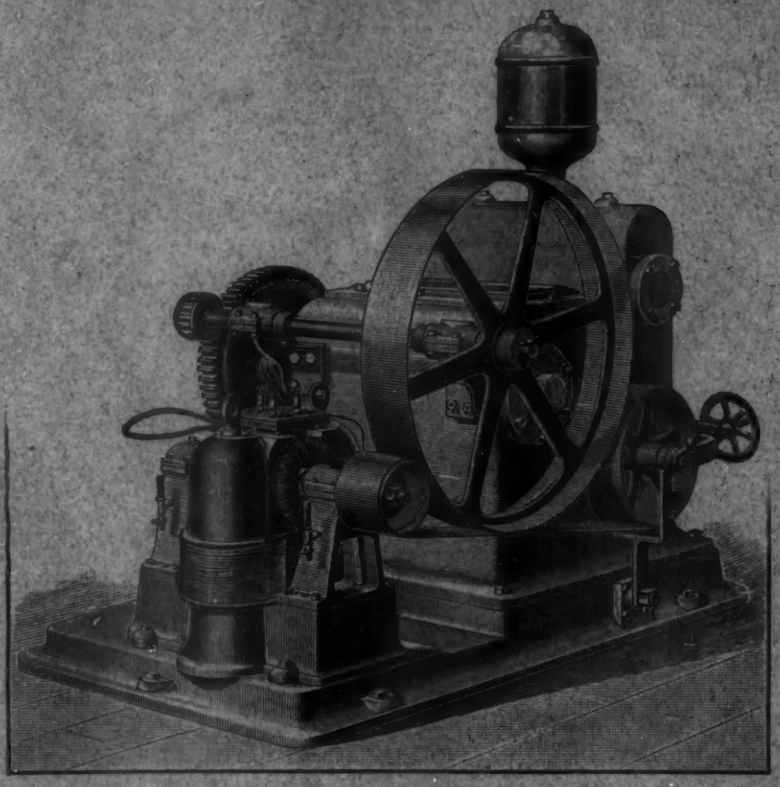

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Devoted to the Conversion, Transmission and Distribution of Energy.

VOLUME XI. SAN FRANCISCO, JUNE, 1901. NUMBER 6.

Electricity in the Union Iron Works.

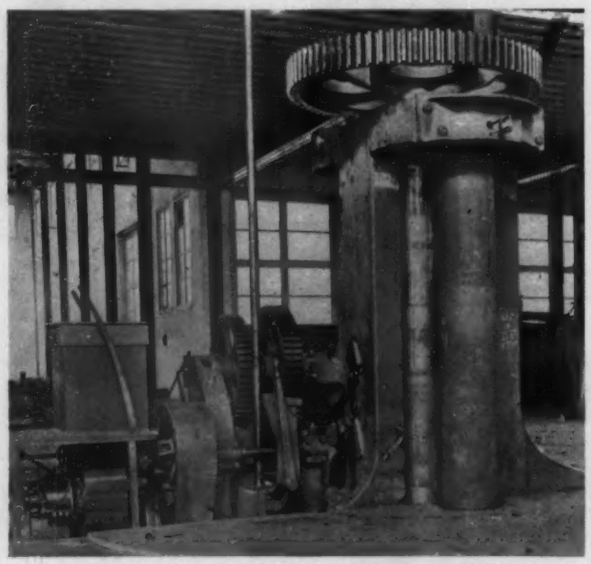
BY W. W. HANSCOM, M. E.

WHEN the Union Iron Works moved from its old quarters on Mission street, San Francisco, to the present location in the Potrero, in the same city, in 1884, electricity played absolutely no part in the then new works and it was not until 1887 that the first dynamo for arc lighting was installed, together with the lamps which were used for illuminating the machine shop and foundry. The generator was a 30-light machine built by the Pacific Coast Electrical Construction Company, with Dr. N. S. Keith at its head, and was of the bipolar, horizontal, double-horseshoe type with wrought-iron field frame and a gramme ring armature. The lamps were low-tension, differential-solenoid, rack-feed, Weise type, using a current of about 18 amperes and requiring 30 volts per lamp. The switchboard consisted of a piece of rough wood upon which was mounted a double-point, single-blade switch, used for cutting out the machine shop when it was desired to run at night in the foundry. The speed of the engine was adjusted to suit the number of lights burning by means of the throttle, and it was the exception when the lights burned—a characteristic of the system being that no two lights should burn at the same time, one lighting up for a few minutes then going out and being followed by the others

MAIN BAY OF THE ERECTING SHOP, WITH THIRTY-FOOT ELECTRICALLY DRIVEN BORING MACHINE IN THE BACKGROUND.

in regular succession. In 1890 a 50-light, 90-volt Brush incandescent dynamo was installed for the purpose of lighting the pattern shop which had, up to this time, been lighted by oil lamps. This generator was driven from the same engine that furnished power for the arc dynamo. Later on the Brush generator was moved to the shipyard engine room and used to supply current to the temporary lights on board ships under repairs or construction, and shortly after to operate two portable electric drills with flexible shafts which Irving M. Scott had purchased during a trip east. These drills were the first electrically operated tools in the works and were soon supplemented by three others, all of which are still in active service.

The temporary electric lights on board ship proved such a saving in time and candles that a 30-kilowatt Edison



TEN-FOOT VERTICAL BENDING ROLLS WITH DRIVING MOTOR.

incandescent generator was soon thereafter installed to take care of the increasing load, the generator being installed in place of the Brush machine.

The flexibility and economy of electricity having been fully demonstrated, it was decided to build a central station alongside the new boiler room then under construction, and a 20-kilowatt, 110-volt, direct-connected Siemens & Halske generator was the first unit to be installed. This was operated in conjunction with the old Edison machine until a further increase was necessary, when the plant was increased by the addition of a 50-kilowatt set similar to the first 20-kilowatt set. Then another 50-kilowatt set followed in a short time, replacing the 20-kilowatt, making 100 kilowatts for the new station.

The introduction of electric cranes, designed for 220 volts, necessitated a change which was met by belting a 25-kilowatt generator from the flywheel of each direct-connected set, running them in series with the direct-connected generators. While this arrangement answered all purposes for a while, the rapid introduction of more cranes and power motors necessitated a further increase and the 50-kilowatt generators were replaced by 75-kilowatt, 220-volt generators, the speed of the engines being increased to suit the new conditions.

The belted generators were direct-connected to motors for supplying 110-volt current for the temporary lights, the motors being supplied from the 220-volt board. Further increase was soon necessary and a 225-kilowatt, 220-volt, direct-connected set, built by the Union Iron Works, was installed to operate in multiple with the others. This was soon followed by another of the same capacity, making a total of 600 kilowatts, which at the present writing is worked up to its full capacity and at times 25 per cent. overload. The entire works with an exception of a part of the machine shop and the hydraulic pumps is operated by motors and the economy of the method has been fully demonstrated.

For the purpose of convenience the system has been divided into the following sections:

1—Cranes.
2—Motors driving groups of tools.
3—Motors driving individual tools, which are fixed.
4—Portable, motor-driven tools.
5—Arc lights.
6—Incandescent lights.

Cranes. There are 35 cranes, from 2½ to 60 tons capacity, two electric capstans and three electric winches.

In the machine shop are two 30-ton Morgan four-motor cranes, traveling on the same track which extends the whole length of bay No. 1 in which are situated all the large tools.

Two five-ton, three-motor cranes, Union Iron Works manufacture, on the same track in bay No. 2 in which are located the small machines. These cranes are operated from the floor by means of six ropes connected with the three controllers so that the one operator can attend to the slinging as well as controlling the movements.

Two 20-ton Morgan four-motor cranes on the same track in bay No. 3 in which are located the medium size tools.

All the Morgan cranes have operators in cages suspended from the under side of the crane and require a second man to attend to the slinging.

In the brass foundry is a 15-ton Union Iron Works crane, operated by means of controllers situated in the center of the side wall. The gases and heat from the metal make it impossible to operate it in the same manner as those previously mentioned.

In the iron foundry are one 15-ton Morgan four-motor crane and one Union Iron Works hydro-pneumatic crane of 50 tons capacity, both having operators located on the crane.

In the erecting shop, over the bay where small machines are erected, are two five-ton, three-motor cranes similar to those in the machine shop, and in the bay devoted to the erection of large engines are one hydro-pnumatic and one hydro-electric crane, both of 50 tons capacity.

The boiler shop is equipped with two 60-ton Morgan four-motor cranes, which run the entire length of the

building on the same track. At the end of the shop and over the hydraulic riveting bulls are two Union Iron Works single-motor cranes, each of 25 tons capacity, which are operated from platforms placed alongside the riveters.

The shipyard blacksmith shop is equipped with one 2½-ton single-motor crane, one five-ton three-motor crane and one 15-ton three-motor crane, all operated from the floor and of Union Iron Works manufacture.

The six shipways are covered by a skeleton framing, each of them being equipped with two five-ton cranes, one covering a little more than half the span, to handle material over the center of the ship under construction and the other covering the balance. Each of the cranes runs on a separate track suspended from the roof trusses and framing. With the exception of ways No. 6 and No. 7, which are fitted with three-motor cranes, the power is supplied by a single motor, the various movements being controlled by friction clutches. Two electric capstans and three electric winches are located in convenient places on the wharves and by the ways for use with jib cranes, hauling cars and warping ships.

Motors driving line shafts and groups of tools. In the machine shop, pattern shop, erecting shop, joiner shop, plate shed and foundry, motors have been connected to the existing line shafts which have been subdivided so as to use motors of not over 50 horsepower and at the same time have an arrangement that would, for night work, permit of the use of only such tools as would be required without running an unnecessary amount of shafting. The load on these motors is very nearly uniform—practically 90 per cent. of their rated capacity—which permits of economical operation.

At present there are five motors of 50 horsepower, eleven motors of 25 horsepower, five motors of 15 horsepower, seven motors of 10 horsepower and one of 7½ horsepower connected to line shafts. Those in the machine shop, with but one exception, being used at present only for night work.

Motors driving individual tools. Individual stationary electrically driven tools are distributed throughout the works quite evenly; the most interesting being in the machine, erecting and boiler shops.

In the machine shop individual motors have been applied to a 30-foot boring and turning mill, gear cutters, planers, lathes, boring mills, grinding machines, cold cutting-off saws—both circular and band—center drills, drill presses and pipe machines.

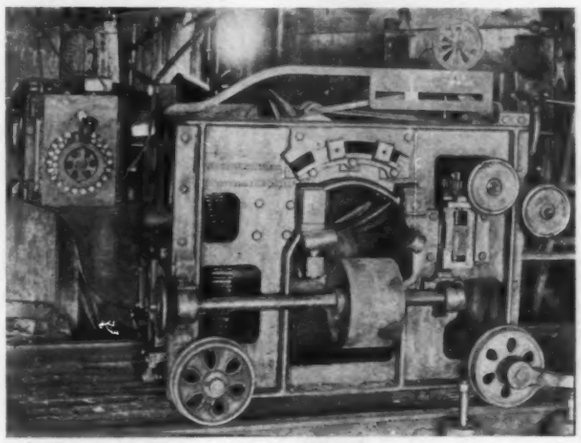
In the erecting shop pipe bending and cutting machines, drill presses and grinding machines; in the boiler shop the large plate rolls, vertical boiler shell drills, combustion chamber drills, staybolt drilling and tapping and inserting machine, punches, shears, edge planers, tube sheet milling machine and manhole cutting and finishing machine, together with the blower for the forges in the flanging shop, are all driven by individual motors.

In the shipyard the nut and bolt retapping and rethreading machine, grindstones and emery wheels, angle iron planing, angle iron beveling, punches, shears, rolls and edge planers are independently driven.

At the end of the wharf is situated a 100-ton shears operated by four 30-horsepower motors, one on each drum for hoisting with the main hook, one on the gypsy and one for operating the back leg. Controllers for these motors are located on top of the house covering the apparatus, where the man in charge has an unobstructed view of the work in hand.

A short distance from the shears is the drydock dredger used to dredge the mud from under the dock. The dock is a hydraulic lift dock and as the space underneath is constantly being filled with mud from the surrounding bottom it is necessary to dredge at regular intervals in order to keep the required depth under the dock. This dredger is operated by a 50-horsepower motor.

At the extreme end of the outer wharf is located the electric capstan used for handling ships around the



ANGLE-IRON BEVELING MACHINE, WITH MOTOR AND CONTROLLER.

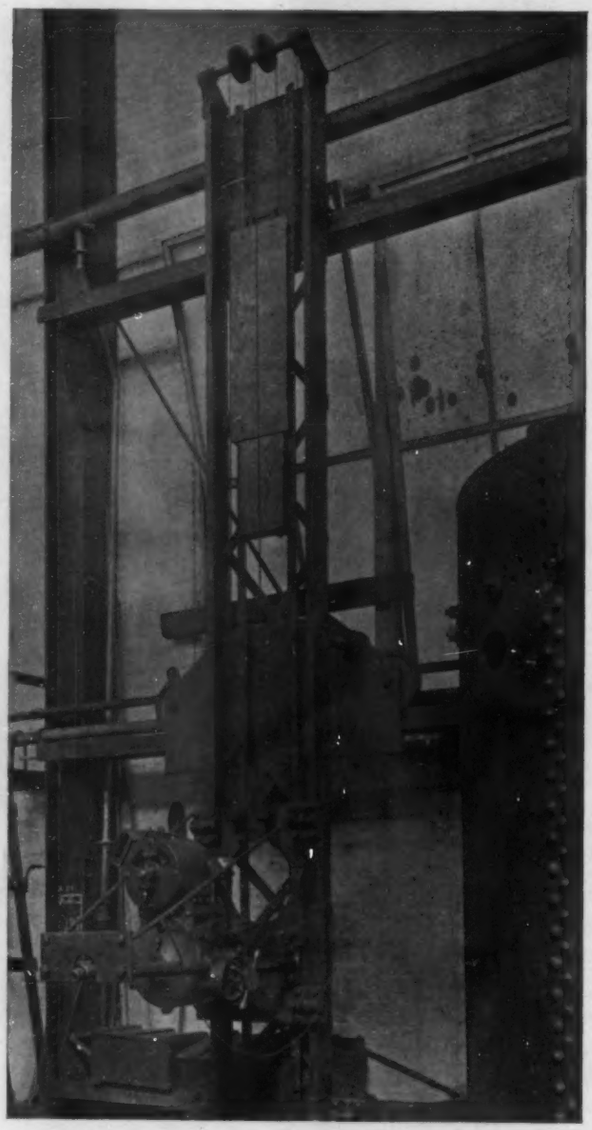
wharves or operating temporary shear legs or other work. It is equipped with a 15-horsepower motor and was designed especially for the work.

Portable electrically driven tools have been designed to meet existing demands and conditions, the following being a partial list of those now in use:

For the construction of Thornycroft boilers, having a large number of curved tubes, a special bending machine, a machine for grinding off the outside of the end where it is expanded into the drum and at the same time chamfering the inside edge, and a machine for expanding the tubes into place, all operated by motors. Portable grinding machines fitted with Stowe flexible shafts for grinding flat surfaces in fitting, drill presses, a portable boring mill for boring cylinders in a vertical position, cutting holes through protective deck plating on battleships and cruisers, milling hatchways with rabbets for armored doors, portable emery wheels for tool grinding on board ships under construction, for boring out stern-tubes, coupling-holes in line shafting, etc. New applications are continually being devised and will, in some future number, be described.

Lights. Arc lights are used for general illumination in the shops, yards and on the dock. At present there are

180 direct-current lamps, most of them being open arcs of Wood, Ward or Thomson type run four in series with resistance, on the 220-volt circuit. This arrangement, although not as economical as the series lamp, gives a more flexible system for night work, the lamps being run off the power circuits where necessary. The 110-volt



AN ELECTRICALLY DRIVEN BOILER DRILLING, TAPPING AND STUD-INSERTING MACHINE.

constant-potential enclosed arcs are used in ships under construction or repair for temporary lighting, and on the dock and in the yards for night work.

All the incandescent lamps in the shop for use around the tools, or machines being erected, are supplied from the 220-volt power circuit and are fitted with portable cords of sufficient length and guards, the cord used being the old style Navy standard hemp, twin conductor, with a heavy rubber insulation and protective braid.

Temporary lighting on board ships under construction or repair is supplied from a separate 110-volt generator located in the general power house. This system is kept entirely separate from the power system on account of the liability of trouble due to the temporary manner in which the lights are installed and the frequent changes necessary during work. The 110-volt current does not rap a man so severely in case the circuits get grounded and any shorts or grounds do not interfere with the power system.

Distribution is on the two-wire system throughout, weatherproof wire being used in all cases except in one or two locations where it has been found necessary to use rubber-covered wire, in wooden buildings, etc.

Feeders run from the main switchboard to distributing boards in the machine shop, erecting shop, pattern shop, blacksmith shop and shipyard plate shop, the various mains being led to these distributing boards.

Circuit breakers are used in the power house on the generators and feeders, the balance of the circuits being protected by fuses. All breakers are set to twice the normal load of the machines or circuits. It has not been found advisable to install breakers generally, owing to the instantaneous current required by machines at times being sufficient to trip a breaker that was set for normal load or a certain overload, a fuse standing the load for the time required but preventing a continuation of an excessive overload. The entire works are covered by mains so that current for temporary power or lighting is available at any point.

The power house is situated in the shipyard, alongside the bay, where it is convenient for condensing water and so arranged as to have the fireroom immediately alongside the coal bunkers.

The generating plant consists of two triple-expansion, vertical, condensing engines, direct-connected to generators, each having an output of 1000 amperes at 225 volts at 265 revolutions per minute. Two compound, condensing, vertical engines, each directly connected to a 75-kilowatt, 220-volt generator at 350 revolutions per minute. The distributing board is separate from the generator board and located in the corner to the right. A third generating set of 50 kilowatts capacity at 110 volts and 350 revolutions per minute supplies current for the office lights and temporary lighting on board ships.

All the boilers are equipped with the Howden forced draft system in which the air is heated by the waste gases before entering the furnace under pressure, the air being supplied by three direct-connected electric blowers. It is intended to install apparatus for burning oil for fuel soon.

Types of motors. For all line shafts, the multipolar open type of motor has been installed, covers being used to protect the motors when not in use. For the direct-connected and portable tools, the enclosed type has been used, suitable provision having been made for the ready inspection of all working parts. Cranes are equipped entirely with the enclosed type of motor.

Total power of installed motors including those on the cranes is 3353 horsepower. Total electrical horsepower of generators, 800. Of the total horsepower in motors installed 1783 is represented by the crane motors, which, practically, give the variable load.

During winter when the arc and incandescent lamps

are in use in the shops the current reaches a maximum of 3000 amperes at 225 volts, the average load during the day being about 1900 amperes on the 225-volt system. Temporary lighting requires from 200 to 400 amperes at 110 volts, depending on the work in hand.

Attendance. All the shop motors, together with all the portable tools, are attended to by one man and a helper who keep the motors cleaned, oiled and the brushes in order, together with all ordinary repairs to rheostats and switches. Any defects are reported and immediately attended to.

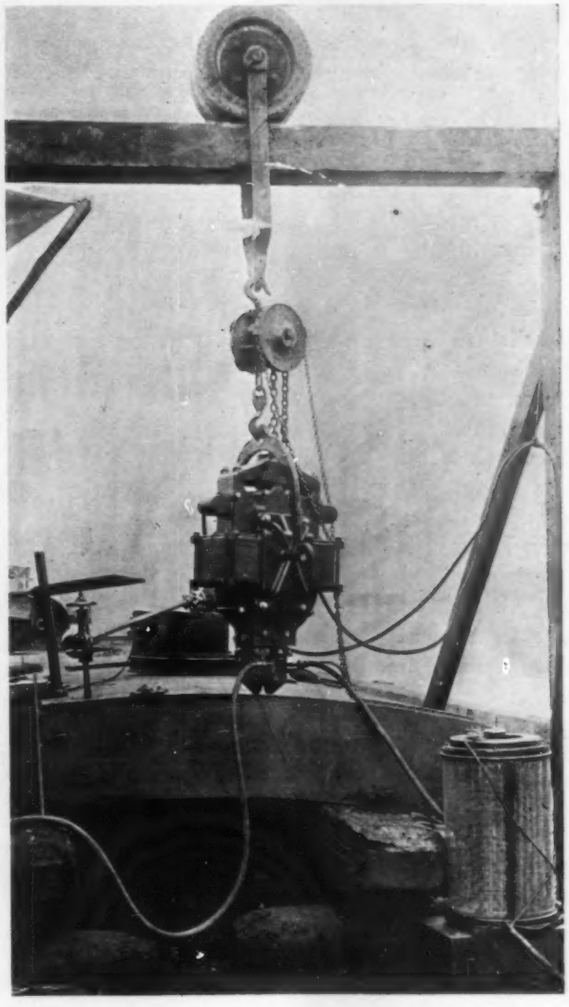
The cranes are attended to by one man and a helper who attend to all bearings, commutators, controllers and minor repairs. The principal source of trouble is naturally the cranes, particularly those that are operated by different men at different times. Here controller contacts, commutators and switches suffer the most. Certain motors, particularly those connected with the capstans and winches, are operated by any man who happens to be handy, with the usual result; but repairs are of a minor nature. Spare parts for all apparatus are kept ready for use so that delay due to changes or repairs is reduced to a minimum.

All of the special motors and most of the standard ones, together with the large generators in the power house, were designed and built at the works, the electrical department manufacturing all the electrical apparatus used on the ships constructed both for the United States Government and the merchant marine.

One of the many interesting applications of electricity to be found in the shipyards of the Union Iron Works is the annealing of armor plates. The nickel-steel armor plates, as furnished the later vessels of the United States Navy, are hardened on the face to a depth varying from one-half to three-quarter inch. This face is such that it successfully resists the hardest steel drill that can be made; and as it is required in the final location of the plate to drill and tap numerous holes in it, it was necessary during the hardening process to protect the desired places by preventing the carbonizing material from coming in contact with them. The operation was not entirely successful, however, as it was found upon trial that although a number of the places were sufficiently soft to be worked, others immediately alongside were as hard as the unprotected portions. A number of attempts were made to locally anneal these hard spots by means of the oxyhydrogen blow-pipe and other apparatus, the most successful being that offered by the Thomson Welding Company, of Lynn, Mass. It was found impossible by all other means than electricity to apply sufficient heat in a concentrated form to attain the desired results, as the large mass of metal surrounding conveyed the heat away as fast as it was supplied. One of the electric welding company's annealing equipments has been installed at the Union Iron Works for annealing armor plates, and the following is a description of the plant and its operation:

The apparatus in general consists of an alternator, with its exciter, a regulating rheostat, a transformer-annealer, and the engine for driving the same. The engine is one of the Union Iron Works' standard vertical compound condensing high speed engines, and develops, at 450 revolutions per minute, 55 horsepower.

The alternator and exciter are of the well known commercial type; the former, of 40 kilowatts capacity, has six coils on as many pole-pieces, the windings being in two series of three in multiple. The armature is of the toothed type, with six coils, connected in a multiple of three series of two. It is wound for an output of 135



THE THOMSON ELECTRIC ANNEALING CONVERTER AND CONTROLLER.

amperes, at 300 volts, when making 1000 revolutions per minute. A pulley on the end of the armature shaft drives the exciter, a D-type, shunt-wound generator of 110 volts, at 2000 revolutions per minute. Its terminals are connected to alternator fields through the regulating rheostat, a cylindrical frame having German silver coils cut into or out of circuit by a contact arm on top. The coils are protected from mechanical injury by the wire gauze covering, which arrangement permits of a constant circulation of air.

The transformer-annealer is of the shell type, and consists of an outer core of laminated iron surrounding both

primary and secondary coils, the former being wound on a form, and incased inside the latter, which is a hollow copper casting made in halves to receive it and then bolted together, after which the remaining space is filled with oil for insulation and as an assistanc in conducting away the heat generated in the primary. The secondary coil has but a single turn, U-shaped, to the ends of which are bolted various shaped copper contact pieces, which are hollowed and connected to a water circulation, thus preventing the heat of annealing from reaching the coils. The yoke from which the transformer is suspended by two trunnions, as well as the aforementioned contact pieces, permit of the transformer being swung into any desired angle and brought against any part of plates already located.

In the operation of annealing, the contact pieces are brought up against the brightened surface of the plate and wedged into position, straddling the spot to be annealed, after the regular rheostat has been adjusted to a point reducing the primary current to a minimum. The distance between the contact pieces for a hole seven-eighths of an inch in diameter, is 1¾ inches. When the contact is established between the contact pieces and the plate, a slight humming noise in the transformer notifies the operator, and the primary current is gradually raised to its maximum. A bright red spot then appears under each contact piece. The intense local heat at these spots causes the plate to expand outwardly, in the direction of least resistance, forming slight mounds from which circles of a gradually changing color slowly approach the center. The primary is kept up until the plate has become sufficiently heated to char or even ignite a pine stick held against it, and then gradually decreased until it has again reached the minimum.

The first or heating period requires about three minutes, during which the secondary current has reached from 3500 to 6000 amperes at three volts. The second or cooling period requires from ten to twelve minutes in order to prevent the sudden chilling of the spot due to the surrounding mass of metal, and to insure a perfect anneal. The plate at the spot of annealing presents a dark blue color, elliptical in shape, with a major axis of four inches and a minor axis of 2½ inches, and is very readily drilled and tapped.

The cut shows the annealer at work on a 17-inch plate. A portable drill press driven by a direct-current motor is shown in the background, ready to drill the holes as fast as the plate is annealed. The regulating rheostat is shown in the lower right hand corner. Four wires are led from alternator and exciter to a convenient spot and connected to annealer and regulating rheostat through a flexible four-wire cable.

The thanks of the author are due to Mr. George W. Ratto, the official photographer of the works, for the illustrations herewith presented.

"Please write the word 'perpetual' opposite my name and let it stay there. I find THE JOURNAL to be the best there is on transmission subjects and I cannot do without it," says Phil. Head, of Torreon, Coah., Mexico.

Miscellany

ON GROUNDS FOR LIGHTNING ARRESTERS.*

GREAT importance must always be attached to the making of proper ground connections for lightning arresters, which should be as short and straight as possible from the arrester to ground. It is obvious that a poor ground connection will render ineffective every effort made with choke coils and lightning arresters to drive the static electricity into the earth, and it is, therefore, important not only to construct a good ground connection, but also to appreciate thoroughly the necessity of avoiding unfavorable natural conditions.

A good ground connection for a bank of station arresters may be made in the following manner: First, dig a hole six feet square directly under the arrester until permanently damp earth has been reached; second, cover the bottom of this hole with two feet of crushed charcoal (about pea size); third, over this lay 25 square feet of No. 16 tinned copper plate; fourth, solder the ground wire, preferably No. 0 copper securely across the entire surface of the ground plate; fifth, cover the ground plate with two feet of crushed charcoal; and sixth, fill the hole with earth, using running water to settle.

The above method of making a ground connection is simple, and has been found to give excellent results, and yet, if not made in proper soil, it will prove of little value. Where a mountain stream is conveniently near it is not uncommon to throw the ground plate into the bed of the stream. This, however makes a poor ground connection, owing to the high resistance of the pure water and the rocky bottom of the stream. Clay, even when wet, rock, sand, gravel, dry earth and pure water are not suitable materials in which to bury the ground plate of a bank of lightning arresters. Rich soil is the best. It is therefore advisable, before installing a bank of choke coils and lightning arresters, to select the best possible site for the lightning arrester installation, with reference to a good ground connection. This may often be at some little distance from the station, in which case it is, of course, necessary to construct a lightning arrester house. Where permanent dampness cannot be reached it is recommended that water be supplied to the ground through a pipe from some convenient source.

Where possible a direct connection to an underground pipe system especially of town or city water main furnishes a very excellent ground on account of the great surface in contact with the earth and the numerous alternative paths for the discharge. In a water-power plant the ground should always include a connection to the pipe line or penstock. Furthermore, as the effectiveness of the arrester is of great importance it should be inspected from time to time, and the resistances and earth connection tested for open circuit.

THE STARTING OF ROTARIES AT BUFFALO.†

BY HENRY GORDON STOTT.

TO provide for the emergency of a total shut-down of the power circuits, those substations of the International Traction Company — the largest user of Niagara power in Buffalo — which have no storage battery auxiliary from which direct current may be got for starting the rotaries, a small motor-generator set is installed, consisting of a 30-horsepower induction motor direct-connected to a 20-kilowatt, 600-volt, direct-current generator. This set is supplied with alternating current by means of a three-phase oil-cooled transformer, reducing the pressure from 11,000 volts to 375 volts; as soon as the power is on the cables the induction motor is started, the small direct-current generator is connected to the busbars, and one of the rotaries is started and synchronized in the usual way, after which the motor-generator set is shut down and the remaining rotaries started from the first.

*Westinghouse Circular No. 1045—abstract.

†Abstract of a paper read before the American Institute of Electrical Engineers, New York, March 22, 1901.

High-Tension Switching and Fusing Devices.

SOME SUGGESTIONS IN HIGH-TENSION SWITCHING.*

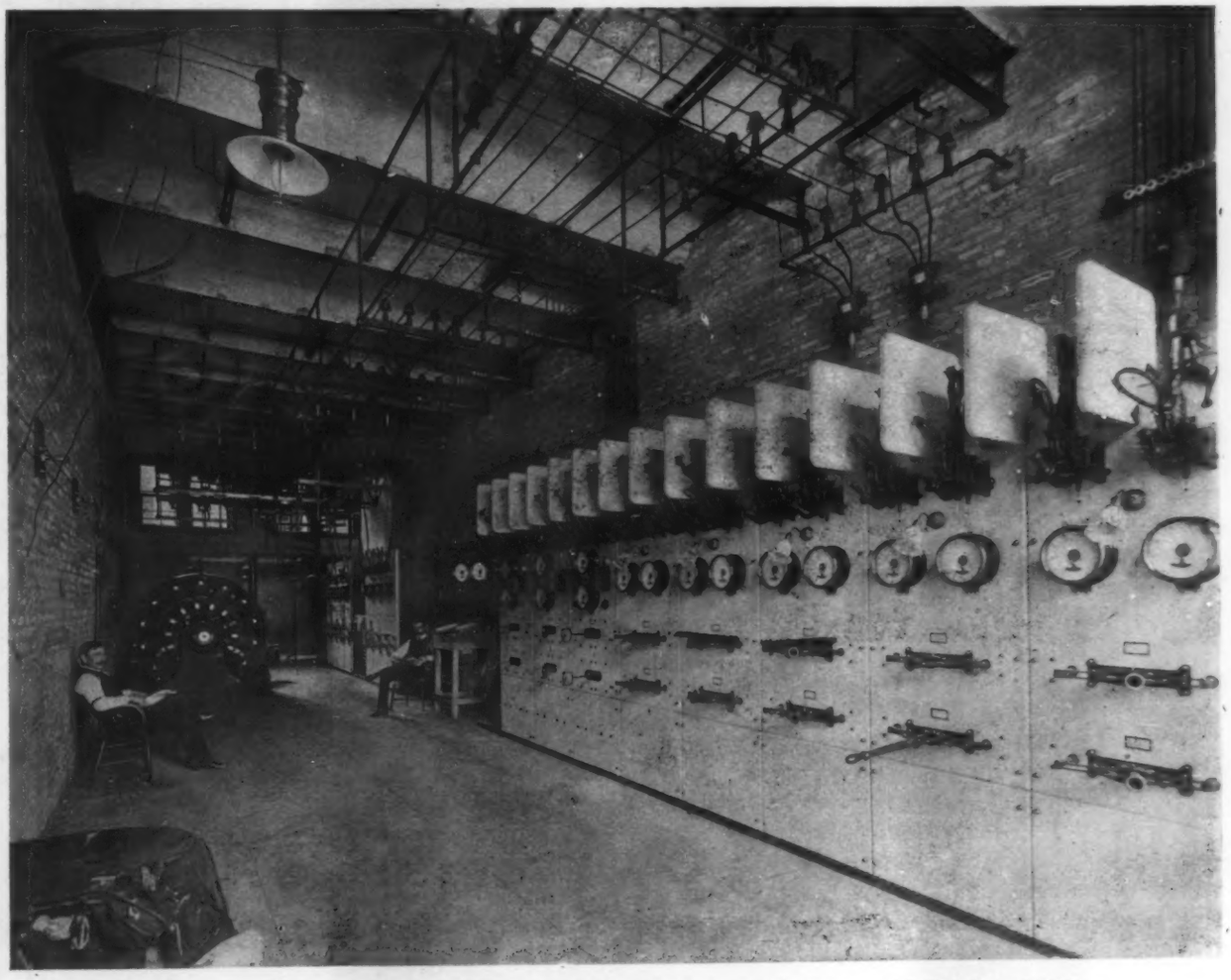
BY R. S. MASSON.

HIGH-TENSION switching is best done when it is not done at all. Circuits having a source of electro-motive force and power each side of a switch may be disconnected without shock or spark, provided no great amount of power is flowing past the switch. This disconnecting is hardly known as switching, and is not harmful. Many high-tension circuits by many causes, among which the following are the most common:

First—Atmospheric discharge. (The heavy disruptive discharge is called lightning. The lighter forms are known as "static").

Second—Sudden short circuits, or grounds on the circuits.

Third—Changing and unbalancing the electro-static capacity of the circuit by switching, fusing, etc.



M. T. SWITCHES IN THE MISSION-STREET SUBSTATION OF THE INDEPENDENT ELECTRIC LIGHT AND POWER COMPANY, SAN FRANCISCO.

plants have for years successfully avoided all high-tension transformer troubles, until increased capacity or excessive prosperity caused the introduction of high-tension fuses or switches, and troubles arrived forthwith. The switches and fuses themselves are harmless and beneficial, but the improper use of them is objectionable.

Abnormal strains are introduced into the insulation of

The first erratic frequenter cannot be avoided, but by proper devices may usually be kept from damaging the apparatus. These discharges are more or less effective, depending upon the distance at which the discharge takes place from the apparatus liable to be damaged.

The second occurrence is unavoidable, except as influenced by good construction work. Its effects also depend upon the relative location of the short circuit and the apparatus to be protected.

*Submitted for discussion at the Fifth Annual Convention of the Pacific Coast Electric Transmission Association, San Jose, June 18-19, 1901.

The protected positions of most water-power generating stations in canyons, and of many substations in towns and cities, remove the greater number of atmospheric discharges to a distance from the electrical apparatus, and render them generally less harmful.

The third class of disturbances—switching and fusing—is directly in the control of the engineer and is very close to the apparatus which is endangered. Many engineers—including the writer—have made the error of placing switches inside the lightning protection apparatus. This is usually forced upon the engineer by the high cost of lightning apparatus, but the system here described avoids the difficulty.

Connecting one or two wires of a long line to a set of transformers gives a badly balanced electro-static condition which causes a heavy static discharge from the low-tension coils of the transformers, and, in many cases, a discharge over the high-tension lightning arresters, thus showing a very high strain upon the general insulation. Making a circuit causes strains nearly as great as breaking it, although not accompanied by the usual pyrotechnic demonstrations.

THE M. T. HINGE.

THE M. T. CLIP.

Fuses are safe enough if arranged at the terminals so as to avoid blowing by bad contact.* Blowing a fuse is always accompanied by heavy load currents, which render the static break-down effect less, if not entirely harmless.

All danger of switching can be avoided by proper arrangements and method of operation. The one fact to be kept in mind in arranging a station's wiring and switches is that no high-tension circuit should be made or broken unless there is a source of electro-motive force and power on each side of the switch, and—when closing—that both sides are in synchronism or that there is no current at all on it. This can usually be done as follows:

Six cases arise, which, with slight changes, represent nearly every generating station installation.

(1) 1 Generator. 1 Set of Transformers. 1 Transmission Line.

(2) 1 Generator. 2 Sets of Transformers. 1 Transmission Line.

(3) 2 Generators. 2 Sets of Transformers. 1 Transmission Line.

(4) 2 Generators. 2 Sets of Transformers. 2 Transmission Lines.

(5) 2 Generators. 3 Sets of Transformers. 2 Transmission Lines.

(6) 3 Generators. 3 Sets of Transformers. 2 Transmission Lines.

In case (1) no switches or fuses are needed, either on generators or on the low or high tension sides of transformers. No advantage can possibly be shown in having an operator open a switch when he stops the plant, or gallantly close it in starting after "he" is up to voltage. Nor is there any advantage in the barbaric fusing of early days, when protection was needed to keep a machine from carrying full load for fear of pulling the winding from the armature, and which remedy, by the way, usually arrived too late to do good—in fact, it was generally applied just in time to add a switchboard grief to the wreck of an armature. Fuses should be used to protect the apparatus beyond the fuses, and not the apparatus toward the source of power. This rule—it should be a rule—is the most abused of them all.

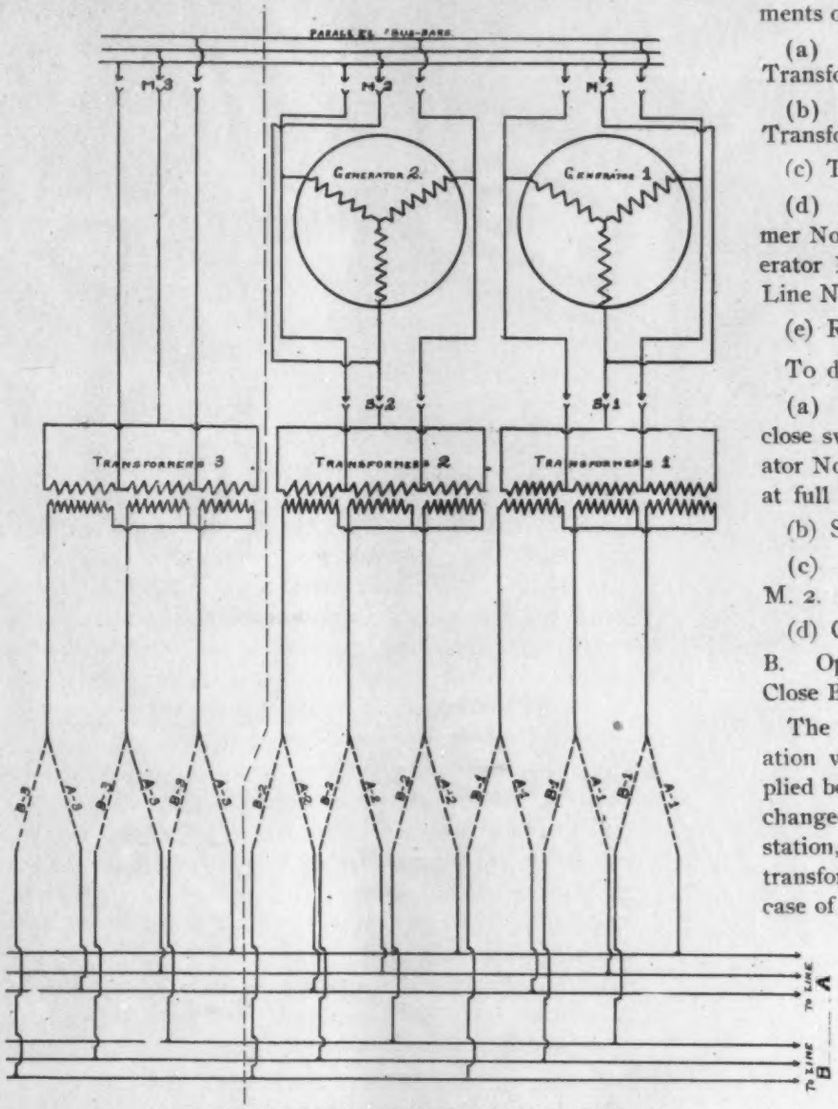
M. T. FUSE AND SWITCH LEVER.

A motor may be protected by a fuse of a size equal to the current which will injure the motor; a line may be protected by a fuse of a size equal to the current which can injure the wire; a generator may be protected by its driving power—the size of the water wheel to equal the point at which the generator may be injured in one-half minute—or the time it takes to shut off the water. A water-wheel may be protected by the size of its nozzle, but to protect a generator by the fuse going to its line is not right in alternating current practice with water-wheel drive. It is much easier to get a plant back to running conditions from a standstill caused by a short than to replace a set of fuses. In protecting one branch

THREE-PHASE M. T. SWITCHES ASSEMBLED.

*If aluminum is used, fuses should be renewed once every month.—R. S. M.

circuit against a short on another, fuses may be used to advantage, but the capacity of the fuse should be rated by what is required beyond the fuse. In case (1) a possible exception may be made by having convenient switches or connectors to release one of a set of delta connected transformers, but no automatic devices should be used, as a shut down would probably occur before the automatic fuses could be blown if they were of such size as to render them safe against accidental blowing, and it would be as well to shut down the plant and then open the connectors or switches as to try to have them automatic, when accidental fusing might interfere with constant operation.



THE MANIPULATION OF HIGH-TENSION SWITCHES.

In case (2) low and high tension switches and fuses should be used on the transformers. The line should be connected to the transformer and generator before starting, or at least to a dead set of transformers, and they should then be connected on the low-tension side to the generator. Transformers should be cut in on low-tension side first, closing high-tension side last, and in cutting out transformers, open the high-tension side first.

In case (3) the same method as in case (2) should be used.

In case (4) more complication arises. Connections for a three-phase delta-y connected set may be made as in Figure 1.

It should be possible to make the following arrangements of the plant:

(a) Start up and run Generator No. 1, Transformer No. 1, on Line No. A.

(b) Start up and run Generator No. 1, Transformer No. 2, on Line No. B.

(c) Throw above in parallel.

(d) Throw Generator No. 1 and Transformer No. 1 on line No. B in parallel with Generator No. 2 and Transformer No. 2 and clear Line No. A.

(e) Restore to condition (c).

To do this operate as follows:

(a) With Generator No. 1 standing still, close switches A. 1 and S. 1, and start Generator No. 1—or with Generator No. 1 running at full voltage, close switches A. 1, then S. 1.

(b) Same as (a) with Generator No. 2.

(c) Close switches M. 1 and synchronize M. 2. Then close B and open M. and M. 2.

(d) Close M. and M. 2, then quickly open B. Open S. 1. Open A. 1. Close S. 1. Close B. 1. Open M. 1 and M. 2.

The No. 2 Generator thus remains in operation via M. 2 and M. 1, and the power supplied being the same, only the transformers are changed. Even if a full load were on the station, a double load would not injure the transformers for this short time, and only in a case of greatest emergency would a line be cut out at full load. If the load conditions run up to near full load a spare transformer would likely be on hand, and by adding one more we would be equipped as in case (5). See portion of accompanying figure to left of dotted line. This expense is not prohibitoyr.

(4 e) Close switches M. 1 and M. 2, then quickly open B. 1. Open S. 1. Close A. 1. Close S. 1. Then at leisure close B. 1 and A. 2 and open M. 1 and M. 2. Transformer No. 1 may be used on Generator No. 2 by removing the brushes on Generator No. 1 and closing M. 1, M. 2 and S. 1.

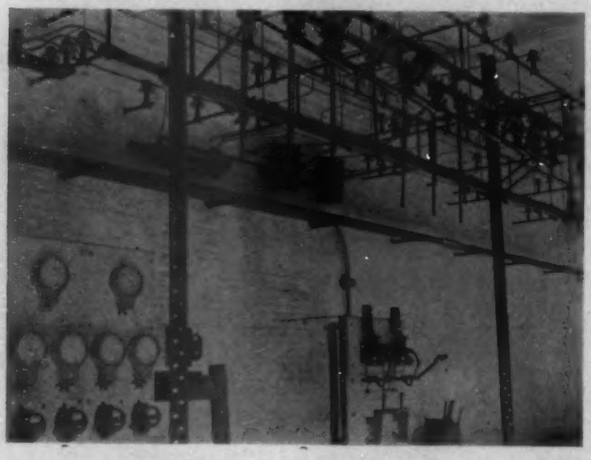
Case (5) is like case (4), but needs no quick work, as each set of transformers may be replaced by the third set, and is better than case (4).

Case (6) is so similar to (4) as to need no explanation. In all operations except those marked "quickly" the

switches may be moved slowly, and should be in control, so that if a spark appears the switch may be put in again and the operator may consider the case to see if he has not gone astray. In opening low-tension switches, S. 1, 2 and 3, in cases where the transformer is in circuit, a slight spark follows.

The good effect of the absence of arcs and fireworks by this method of operation must appeal to any station operator.

The high-tension switches for this method of operating need only have the following qualifications: First, the insulation of all parts from ground and each other, equal to the line insulation; second, simplicity of operation; third, they must be capable of being opened slowly and returned if an arc appears, hence a quick break



M T SWITCHES IN 11,000-VOLT SERVICE.

switch would not be suitable for this purpose; fourth, they must be arranged for rapid action, and fifth, they must be of the two-way and not of the double-throw variety.

High-tension fuses should have an insulation to ground equal to the line insulation, and they should be enclosed in parallel tubes so that arcs may not pass from one to the other.

All high-tension wiring and all possible high-tension switch parts should be rubber covered, or at least weatherproof where great economy is necessary. Switches and fuses should be well separated and as much room as is available should be used.

Substation operation should be practically the same as generating station operation, and in throwing transformers on to a high-tension line whenever there is more than one set of transformers on hand, the station should be arranged so that if one set is in operation the other set may be thrown in on the low-tension side first and the high-tension switches then closed. Even where the transformers are used to feed independent circuits from th substation, it would be advisable to arrange double-throw low-tension switches so that they may be thrown in on the same circuit until after the high-tension switches are closed, and then be thrown over to their own circuit. It would even be advisable, in case two transmission lines were running non-synchronously, to throw them in multiple by switches M. 1 and M. 2 in order to make this connection of an additional set of transformers.

It may not be dangerous to throw transformers in at substations when there is a case of emergency, but this operation, when repeated, has the usual effect of a repeated abnormal strain and will eventually bring about bad results.

Lightning arrester apparatus, which is so frequently wrecked on account of sparks passing over it occasioned by switching lines of transformers in and out, is preserved and kept from carbonizing and short circuiting by this method of operation. Line insulators receive less strain, and frequently punctures are avoided.

The Independent Electric Light and Power Company's plant in San Francisco is arranged in this way, and it was a very fortunate arrangement, as it was found impossible to disconnect the underground cables from the transformers feeding them when the current was on without danger of puncturing the cable insulation.

The above method has been used ever since this plant started its operations, and no complications have interfered with the rapid and effective operation of cables and transformers.

EXPERIENCES OF CENTRAL CALIFORNIA SYSTEM.*

BY R. W. VAN NORDEN.

WHEN the transmission of the Central California Electric Company was installed,* marble plug boards were provided at the receiving end of the 15,000-volt transmission and later at the Newcastle generating station. Wires from the raising transformers were connected in multiple to the original three-line wires after passing through aluminum fuses about 18 inches in length. At the receiving end, after passing through the plug board, three fuses similar to those at the generating station were inserted, and from there the wires fed the bank of lowering transformers. This arrangement proved to be defective on many occasions, as an accident or short circuit at any one transformer or even beyond blew at least two fuses. The plugs had to be pulled only when there was no load, consequently they were of little use.

Later a second bank of transformers was installed at the sub-station, a second circuit was erected on the transmission line and an additional power-house was built at Auburn, six miles distant from Newcastle. The line from Auburn was run directly to the Newcastle power-house, and at that point a double plug board was installed so that either power-house could be switched on either or both transmission lines. A similar board was placed in the sub-station, two circuits running from it, one to each bank of transformers. At all three stations individual fused cut-out were placed on the high-tension side of all transformers, and at the sub-station

* Submitted for discussion at the Fifth Annual Convention of the Pacific Coast Electric Transmission Association, San Jose, Cal., June 18-19, 1901.

single-pole quick-break switches on the low-tension (2400-volt) side, together with fuses. By this means any accident to an individual transformer, both high or low tension fuses would blow and thus cut it out. The use of main line fuses was discontinued in all cases.

In the plug boards the wires lead from the rear to a hard rubber receptacle placed in an opening through the panel, the opening in the receptacle being about three inches in depth, and having connected from the rear with the wire and extending towards the front, a split pin with an enlarged head, the pin being 3-8-inch diameter and 2 inches long. The plugs are of hard rubber, about 10 inches in length, and closely fit the receptacle; they enclose a brass bushing which fits over the pin, the flexible rubber covered cable running into an opening at the side of the plug. The outer end has a brass bushing in which a wooden handle may be inserted to remove the plug.

These plugs and cables have proved to be electrically serviceable, and will break the circuit on a load, although it has never been attempted but once or twice. The cutting in and out of either transmission line or the line to Auburn necessitated by line repairs or for other reasons, very soon injured or partially destroyed the plugs, as it was found very difficult to keep perfect contact between the pin and bushing, and often on full load the plug would get so hot from sparking at the contact as to melt the rubber and make it next to impossible to remove the plug without taking out the entire receptacle. The plugs and cables are very heavy, and clumsy, which makes them difficult to handle. The entire set at the Newcastle power-house has been replaced with the Masson-Taylor switch, heavy wire being substituted for fuses.

The individual cut-out fuses consist of a stick of hard wood about eighteen inches in length, on either end of which is a blade of heavy sheet copper extending at right angles to the wooden stick, while between the blades is suspended from a screw in each the copper-wire fuse, over which is slipped a piece of rubber tubing. In the center of the stick is a wooden handle. This cut-out fits into a pair of copper clips soldered to a heavy copper wire, which, in turn, is fastened to a glass insulator. The two insulators are placed so as to give the cut-outs a position about 20 degrees from the perpendicular, excepting at Newcastle, where they are horizontal. We have experienced no difficulty in cutting in and out transformers by this method, and although we have on several occasions had fuses blow on short circuit, the burning of the fuse wire has in every case immediately opened the circuit.

We find the new switches at Newcastle an immense improvement over the old apparatus, and they have so far given good satisfaction.

John A. Britton, President Oakland (Cal.) Gas, Light and Heat Company: "Permit me to extend to you my congratulations upon your excellent number. It is something that you may well be proud of."

THE MARTIN HIGH POTENTIAL SWITCH.*

BY F. V. T. LEE.

THE Martin High Potential Switch was first designed and built in the spring of 1898, and was designed for the purpose of fulfilling the specifications and requirements of the Yuba Power Company on its 16,500-volt line.

The time available for the designing and mannfacturing of this switch was exceedingly limited, and as the designers had had little or no experience in this work, it will not be surprising to know that it underwent a great many modifications before the type "A" high potential switch was developed. This switch as then built is shown open and closed in Figures 1 and 2, a front view of this switch closed being shown in Figure 3 and the details are shown

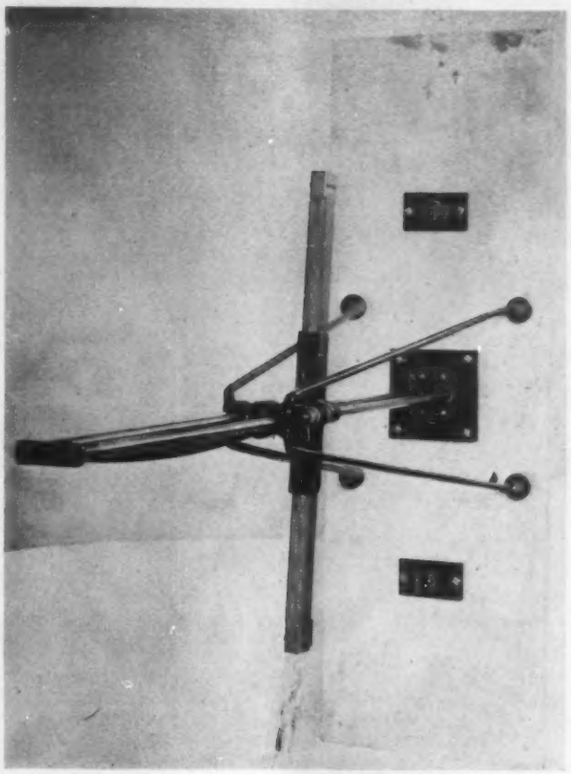


FIGURE 1.—THE ORIGINAL 16,500-VOLT MARTIN SWITCH, TYPE "A." REAR VIEW, OPEN.

in Figure 4. The subsequent modifications of this switch have been entirely confined to details and not to the general principle. While the writer prepared the designs for this switch, they are really the result of the experience of all who were connected with the designing of the original plant of the Yuba Power Company.

Briefly, the switch could be described as a double break single pole switch, each break being eighteen inches in length, so that the resulting break on the switch proper can be considered as thirty-six inches. The current enters the upper terminal of the switch and passes through the contact jaws and blade from a conductor which is embedded in soft rubber and then encased with-

*Submitted for discussion at the Fifth Annual Convention of the Pacific Coast Electric Transmission Association, San Jose, Cal., June 18-19, 1901.

in two strips of fiber. At the lower end of this fiber switch bar the current leaves the blade and jaws of the switch to the other terminal of the line. The switch rods on which the switch bar slides are made of cold rolled steel shafting and the bar and rods run on babbitted

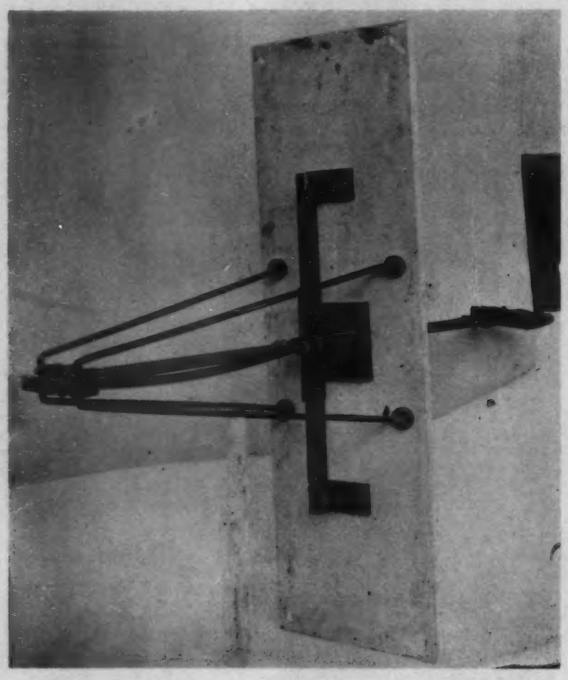


FIGURE 2.—THE ORIGINAL 16,500-VOLT MARTIN SWITCH, TYPE "A." REAR VIEW, CLOSED.

bearings throughout. By this construction a very accurate and satisfactory fit is obtained. The method of operation is very simple, as the switch bar when closed is held by a latch, so that there is no possibility of the jaws working loose. When the switch is closed the main operating spring is not in tension, nor, indeed, is it ever in tension except at the instant the switch is thrown. To throw the switch, the switch rods which are connected to the insulated handle are pressed in to their fullest extent, placing the operating spring under considerable tension. Just as the operating handle is pressed home, it releases the latch holding the switch bar, and when so released the switch bar is free to be drawn from the jaws and pulled open to its fullest extent, and, as a result, the switch opens so quickly that the arc is not able to follow and is immediately disrupted.

Sometime in 1898 the switch was tested by Dr. F. A. C. Perrine and a number of his students under very severe conditions—that is to say, the switch was broken when a potential of between 33,000 and 36,000 volts was applied, and under these conditions acted in a very satisfactory manner, although, as a matter of fact, the current was not very great. A very interesting photograph was taken during the time when the switch was being opened. This is reproduced in Figure 5. In addition to this test, however, these switches were frequently used for opening the lines of the Yuba Power Company under very severe short circuits. In every case they responded in a perfectly satisfactory manner under the heaviest load, showing no effects of the arc at the terminals. In designing this switch, the fact that some trouble might be experienced at the terminals under excessive short circuit was borne in mind, hence the jaws may be very readily renewed, they being held in place by taper pins which can be driven out and new jaws inserted without any difficulty.

Later on it was necessary to design a switch of this character for the 5500-volt circuits of the Nevada County Electric Power Company, and for this purpose the type "B" switch was designed. This switch in design is essentially the same as the type "A" switch except that in designing it, in order to allow of a stronger actuating spring, the center part of the switch was mounted on an oak panel, this being inserted for the purpose of eliminating the danger of cracking the marble in case the operating spring should be too strong. The shock of opening the switch, however, is taken care of by two pairs of buffer springs and a number of rubber washers. The switch bar on reaching its full opening is brought up against

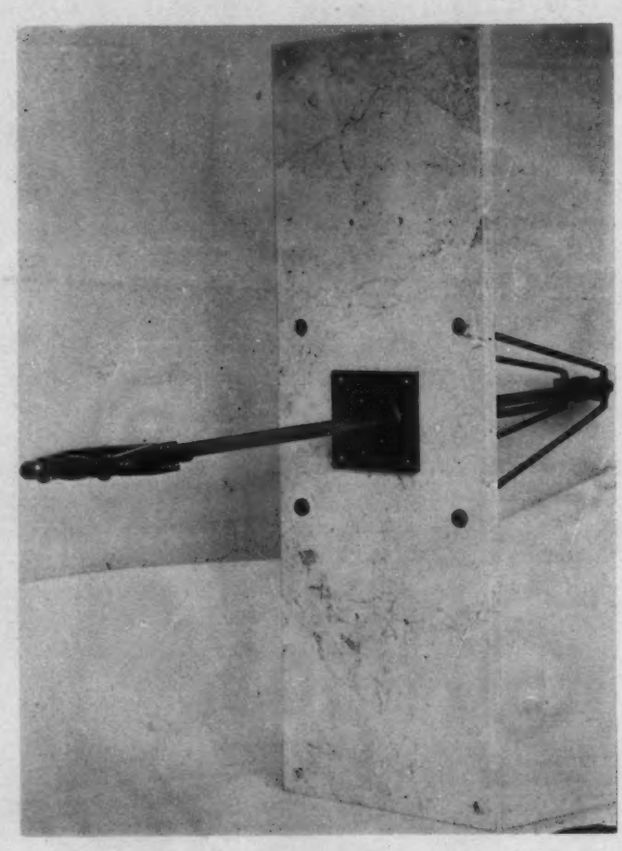


FIGURE 3.—THE ORIGINAL 16,500-VOLT MARTIN SWITCH, TYPE "A." FRONT VIEW, CLOSED.

the first pair of buffer springs, which are secured to the switch rods, and the shock in this way transmitted to the rods. Buffer springs are also placed in front of the handle, and when the shock is transmitted to the rod through the medium of the first set of buffer springs, it is finally

taken up through the second set of buffer springs mentioned, which finally transmit what little shock may not have been absorbed to the wood panel on the front of the board. Figures 6 and 7 show a gang of eight of these switches in front and back view. In this connection may be added that these photographs are shop photographs, and the hard rubber buttons which are set in the marble and oak panel covering the heads of the screws have not been inserted.

A great number of switches of this type have been installed on the Nevada County Power Company's circuits, and are also used for synchronous motors, the Nevada County Power Company using them for handling all their 5000-volt circuits, and have installed on one board at their Grass Valley sub-station has not less than sixty-four of this type of Martin switches.

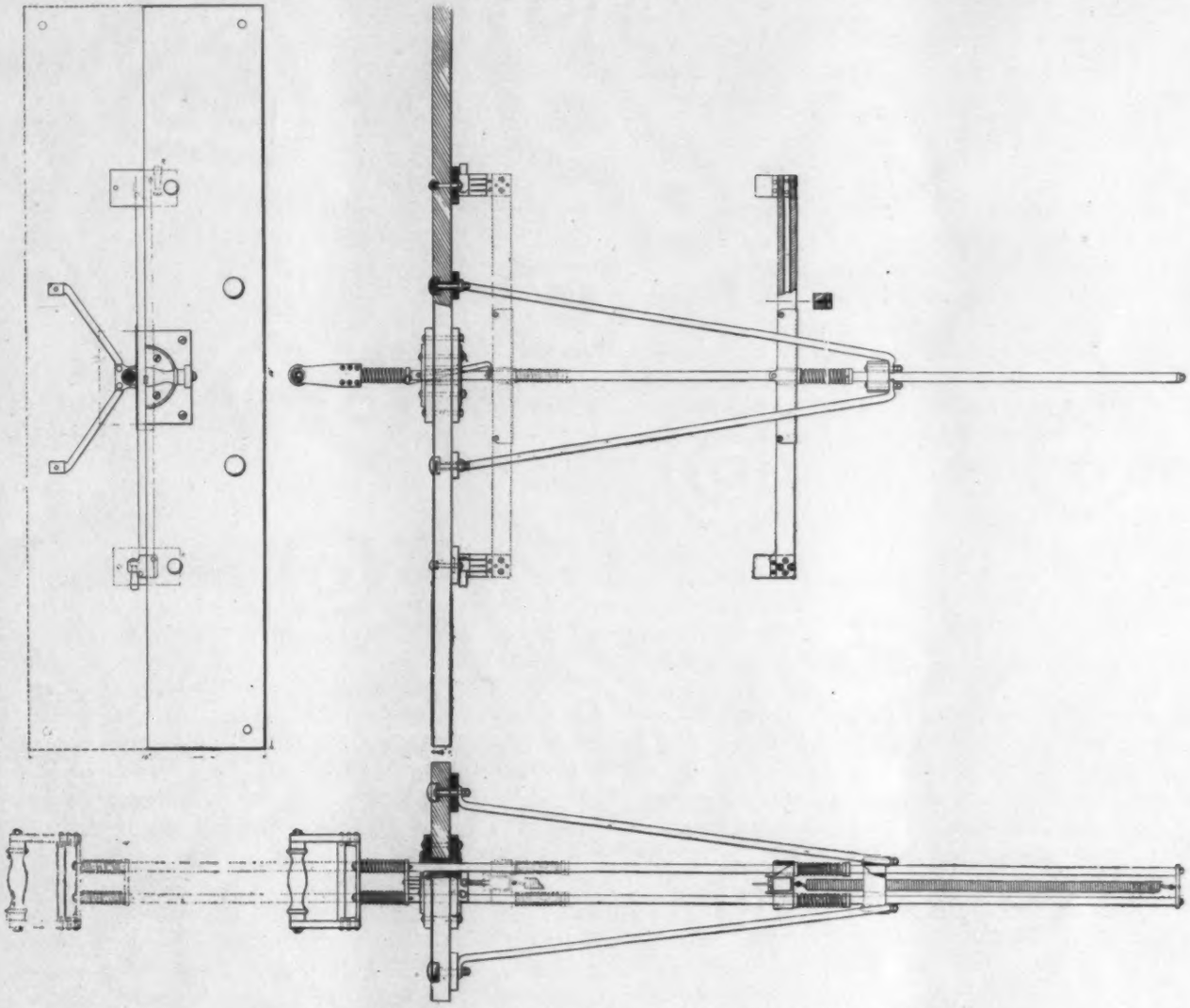


FIGURE 4.—DETAILS OF THE ORIGINAL 16,500-VOLT MARTIN SWITCH, TYPE "A."

After a number of the type "A" switches had been built it was found that the wrought-iron brackets used for supporting the outboard bearing was unnecessary, and as a result the present form of Martin switch was developed. This switch in its 5500-volt form is known as the type "C" switch, Figure 8 being front view of this switch closed and Figure 9 a rear view of the switch open. Figure 10 is an outline drawing of the switch and shows very clearly its construction. It, however, contains several very important modifications to which it would be well to call attention. The method of operation, however, is the same for all types.

The modifications in the type "C" switch consist of the elimination of the outboard bearing which was rendered possible by the extension and lengthening of the main bearing of the switch, which it was found was capable of supporting the switch rods in a perfectly satisfactory manner and has sufficient rigidity, thus eliminating the brackets previously used, and by such elimination leaving the back of board free from what, in some cases, might result in a very difficult wiring arrangement where a number of busbars were installed.

It was not always possible in this switch, although at all times desirable, to have the jaws sufficiently tight to give a good contact and at the same time avoid the instal-

(Continued on page 127.)

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EDITORIAL.

GETTING DOWN TO BUSINESS.

As the first of these forms go to press the Pacific Coast Electric Transmission Association is closing its Fifth Annual Convention at San Jose, and the meeting has been more remarkable in many respects than any to which western electrical nterests have ever gathered. Whatever may be its worth from a technical standpoint, the San Jose convention has done more for the welfare of long distance electric power transmission *in a business way* than has any of its predecessors — it has cemented the members of the Association together in bonds of enduring good will and fellowship, it has broken down the barriers of provincialism which characterised the earlier meetings, and it has enacted new features which will force the Pacific Coast Electric Transmission Association to the front rank of the industrial societies of the world. These are triumphs of no mean order, and they betoken far more good for the Association and its future than any number of papers, however able, or any amount of discussion, however brilliant. The San Jose Convention marks the awakening of a new era of progression and development.

San Jose, the "Garden City" of California, and fifty miles by rail from San Francisco, affords a meeting-place altogether different from that of the last convention, for the Tavern of Tamalpais is at a mountain top where gorgeous sunsets and unmatched vistas prevail, while the Hotel Vendome — a del Monte in miniature — is hidden away in a charming residence section of one of the most beautiful cities of the state, where trees vie with lawns and birds with flowers to add to human happiness. Within perfect appoitionments and exquisite service compelled content, for modern hoteldom leaves naught to be wished for by anyone.

The bulk of the membership of the Transmission Association, numerically considered, is credited to the associate membership class, specifically defined in the constitution and by-laws of the Association as constituting "any corporation, firm or individual engaged in the distribution of electrical energy, or engaged in the manufacture or sale of electrical apparatus or supplies, or any electrical, mechanical, hydraulic or civil engineer." A demand has arisen for the institution of a separate degree of membership, the qualification for which shall be proficiency in some branch of engineering with which electrical transmission interests are allied, whether this branch be in electrical, mechanical, hydraulic, civil, chemical, pneumatic or other lines. It matters not, under the new amendment to the constitution and by-laws, whether the applicant for membership to the newly-created class of Associate Engineers of the Transmission Association, be an independent engineer, or whether he be an engineer for a transmission company, or whether he be an engineer for some manufacturing industry or selling agency, he may still become an Associate Engineer provided he has the proper qualifications and attainments. Associate Engineers will possess the membership privileges to which associate and honorary members are entitled, and it is among the possibilities that they will go further than this, even to the extent of organizing a society that shall be auxiliary to the Transmission Association, and devoted to the discussion of problems which arise along the technical and engineering sides of long distance high voltage transmission. Indeed the plans now maturing for the development of this branch of membership will, it is hoped, make the Associate Engineers of the Pacific Coast Electric Transmission Association a most valuable adjunct.

Apropos of membership, it is a lasting pleasure to announce the election of Mr. W. R. Eckart to honorary membership — and never has the Association bestowed the distinction upon so merited a person. All the Western mechanical, mining and electrical world acclaims as with one voice the fact that Mr. Eckart's wide experience and ripened knowledge has brought him to the proud position of being the most eminent mechanical engineer of the Pacific Coast, for the man whose genius is reflected in engineering work extending from the mastodonic pumping engines of the bonanza days of the Comstock down to the absolute perfection of the extraordinary mechanical and hydraulic features of the Standard Electric Company's power house at Electra, and the man whose advice is as earnestly sought for and implicitly followed by his employer of twenty years ago as it is by his newest-found client, is the man whose record is unapproached in Western engineering annals. Honorary memberships are, and must be, bestowed but sparingly, but were there a thousand W. R. Eckarts in the engineering field, the Transmission Association could not, in justice to itself, do otherwise than give to each the fullest meed of recognition and endorsement.

The papers presented to the Convention, though few, were of great merit, embracing as they did discussions of the topics of electricity in pumping and telephony in

transmission service, and the subjects of high tension switching and pole line construction. The three most noteworthy electric power transmissions in California today are those of the Bay Counties Power Company, the Edison Electric Company of Los Angeles, and the Standard Electric Company of California, and the papers of Messrs. C. E. Dutcher and C. O. Poole described the features of construction of the Bay Counties and Standard systems respectively. Both authors brought out the fact, which certainly seems to have been given inadequate consideration heretofore, that today the most susceptible portion of any long distance high voltage transmission system rests in the transmission line, and that to perfect this line to such a degree that it will prove trustworthy and reliable at all times and under all conditions of service and of weather is a problem which has called for the exercise of a degree of engineering skill of no mean order. Drastic as the statement that the line constitutes the portion of a transmission system most susceptible to injury may seem to be, none will gainsay the fact that by far the great majority of the comparatively few shut-downs which occur in electric transmission service are due to breaks in the line. Generators practically never break down of their own accord and from inherent infirmities, provided they are properly handled and cared for; transformers are devices which are entitled to almost equally favorable consideration, if there be barred the injuries resulting to strains to which they are ofttimes subjected from overload and the short circuiting due to line and other troubles — in fact, if proper care be given to generators and transformers, it is hardly too much to say that they would give immunity from interruption to service could they be freed from the contageon inherent to the hydraulic and line equipments. As it is, possibly 75 per cent. of the shut-downs occurring in transmission service may properly be charged to the line, and a realization of this contingency was largely instrumental in causing the Standard company to install storage batteries in its substations, and causing the Bay Counties company to erect a double pole line.

It is plain, therefore, that too much attention can not be given to details attending the construction of this most sensitive yet vital portion of transmission mechanism. Laying as it does beyond the scope of the eternal vigilence that is given to the power house, exposed to the relentless whims of wind and weather, of lightning and of temperature, and, being too frequently the target for the thoughtless marksman, who shoots insulators in sport yet renders a system death-dealing that would otherwise be harmless— all these are characteristics of pole line engineering, the consideration of which indicates some of the obstacles to be surmounted in its construction and maintenance. The two papers referred to present the best practice that is being followed in pole line construction in the very heavy and altogether noteworthy systems named. As such, they are valuable contributions to transmission literature in that they open up a subject well worthy of much future discussion, as well as one that is bound to be one of ever growing importance.

The fact should be recognized that during the last two or three years the electric power transmission interests of the Pacific Coast have been going through a crucial period of development, and that now, thanks to their tireless energy, they are emerging into the commercial sphere which makes them most prominent in the business welfare of the Golden State. As a result, it is safe to say that no busier a lot of men as a class are to be found than are the managers and associated engineers of the companies affiliated with the Transmission Association. They are, every one of them, so wrapped up in their work, body and soul, that it becomes a serious undertaking for them to get out of the rut of business routine and into the way of association matters. Nevertheless two engineers of prominence, and who are both most sorely taxed for time, namely, Messrs. Lewis A. Hicks and T. E. Theberath, did succeed in preparing papers which proved to be of more than usual value.

Mr. Hicks' investigations into the uses and applications of electric power in centrifugal pumping service were first brought before the engineering world through the publication in these columns of a paper which he read before the Third Annual Convention of the Transmission Association on "Electrically-Driven Centrifugal Pumps." In this paper Mr. Hicks deliniated the results of many experiments which he had performed in the operation of centrifugal pumps by electric power derived from the transmission of the Power Development Company, of Bakersfield, Cal., for the irrigation of the great property interests of the Kern County Land Company. The present paper is the refinement of the interesting work then undertaken, for it discusses the limitations and possibilities of electric power transmission in pumping service from the broader standpoint of general experience throughout the state.

Telephony over circuits placed on high tension long distance pole lines in transmission service has been the subject of special study on the part of Mr. Theberath during the last three years or so, in which he has been engaged in construction engineering work for the Bay Counties company. He possesses, above all else, the courage to carry out his convictions despite all opposition, and as a result the engineering annals of California transmissions must record that the Theberath conception of carrying telephone lines through straight, *i. e.*, without transposition, on the 40,000-volt, 142-mile pole line of the Bay Counties company from Colgate to Oakland was a most daring undertaking. It was, in fact, one upon which Mr. Theberath virtually risked his engineering reputation, for he stood alone in its support, and to him alone belongs the credit for its unqualified correctness.

Of course, such telephone lines are most successful when the power lines are free from leakages and are running under balanced phases, but it is now demonstrated that the same is true whether the telephone lines are run straight or transposed. The telephone is, as Mr. Theberath's paper points out, so infinitely sensitive as a current detector, hunting out as it does even millionths of an

ampere, that the problem confronting those who attempt to get absolutely quiet service over wires run on transmission pole lines, is one that appears to be inherently impossible of solution, especially when it is remembered that the telephone wires are susceptible to practically each and every effect known to electrical science. But Mr. Theberath's theory declaring to the effect that transposition in telephone lines is unnecessary, provided the power line be properly transposed, stands vindicated.

A conspicuous feature of the papers on high tension switching which were presented for discussion, was the practical absence of assurance that the switches described would, under guarantee, operate successfully under the extreme ranges of potential and current to which the transmission practice of today subjects them. The truth can not be gainsaid that in high tension station switching, circuit breaking and fusing the electrical engineer of today is confronting an unsolved problem. "Juice" at potentials ranging from 40,000 to 60,000 volts is almightily "hot stuff," so hot, in fact, that it goes far beyond any previous conception that might have been had as to its breaking down proclivities. When high tension switches come from factories that have specialized in their manufacture, and are set up in conformity with the best ideas of the most capable transmission engineers of the century, with insulators, and insulating materials, and filled and treated timbers everywhere, and when these timbers, for instance, although apparently adequately insulated themselves from the live parts of the switches, become so hot, literally and figuratively, that they sizzle and bubble and finally blow out smoke from every crevice and nail-hole, then, when these things are seen, will it be realized that the building of switches, circuit breakers and fuses for handling these lines is by no means a commonplace undertaking. Nor is it one which can be solved in the laboratory, for all electrical San Francisco knows that a well-known type of circuit breaker for use on so low a potential as 11,000 volts in a system finished within a year is now a useless, tied-up and permanently short-circuited device. But the good work is going on and the high tension switch and circuit breaker is undergoing the stages of evolution which must ere long place transmission interests beyond the stage where they must temporize in the commutation of high tension circuits. The industry does not suffer for the lack of these switches, but it must be and is confessed that their perfection will do much toward facilitating line and transformer manipulations in such directions, for instance as Mr. Masson's paper so forcibly indicates. Again, in considering this subject it must be borne in mind that some of the latest devices described have not been put in service as yet, or if so, that they have not been in service a sufficient length of time to demonstrate their worth, but regardless of this, there is today no indoor high tension switch and fusing device in use in extremely high voltage transmission work in California which has earned universal approval.

A hitherto-neglected side of the Transmission conventions has been its social features, but the San Jose meeting demonstrated the wisdom of those who have from the outset contended that the associations should throw off every taint of provincialism and rise in a social way to the dignity of the widespread interests which it represents. The San Jose Convention was especially distinguished in that there was a goodly attendance of ladies.

The second surprise along social lines was due to the munificence of the Electric Improvement Company of San Jose, which, through its President, Mr. F. M. Pickering, and its general Manager, Mr. H. J. Edwards, became the hosts of the convention. A ride in special cars, extended through the courtesy of the San Jose Street Railway Company. carried the members through principal streets of the city to the new steam-driven polyphase station of the Improvement Company and the San Jose substation of the Standard Electric Company, forming the terminus of the 184-mile, 40,000-volt transmission from the Bay Counties Power Company's great station at Colgate, in Yuba county, and from which the entire electric railway system of San Jose is being operated. Next the visitors, together with some forty odd reperesentative citizens of San Jose, were taken to Alum Rock, a beautiful canyon in the Los Buellis hills six miles east of the city, in a special steam train, where an elaborate luncheon was served beneath the spreading branches of great live oaks. Nurtured by such good things, after-dinner oratory held sway for an hour or so, when the return was made in ample time to allow the delegates to the convention to reach San Francisco in the early evening.

And after it was all over, all were united, first, in the belief that the Transmission Association had at last gotten down to a solid basis for good hard work, and, second, that the Electric Improvement Company of San Jose had set a pace for the entertainment of the convention that future hosts will find it difficult to keep up with.

ELECTRICALLY DISTRIBUTED WATER POWER.*

BY ALTON D. ADAMS.

WITH electrical distribution of water power only a small space is necessary for the few large wheels and dynamos that absorb the entire energy of the water. Mill sites, instead of being confined to a little land along the banks of a river or canal, at once expand to include the territory within five, ten or a greater number of miles of the generating plant. This expansion of service area affects the number and the character of power users. The number of industries is limited only by the water available, and the capacity of each may be either great or small. Since mill sites have come to include all the land within a long radius that is not required for other purposes, the opportunity to buy cheap power has only a slight influence on rents. Almost the entire saving in the cost of power is thus free to be divided between the water company and its patrons.

A distinct feature of electrically distributed water power is the advantages it offers to manufacturers of small and medium capacity. The consumer of 100 horsepower will probably have to pay somewhat more per unit than the consumer of 1000 horsepower, but the difference in rates will represent only a small fraction of that in cost which would result were a separate water wheel installed for each case.

*Cassier's Magazine, Vol. XVIII, page 485, October, 1900.

High-Tension Switching and Fusing Devices.

THE MARTIN HIGH POTENTIAL SWITCH.

(Continued from page 123.)

lation of an excessively strong operating spring. This difficulty was obviated by the installation of two small steel pins, or "pushers," which are very clearly shown in the outline drawing. These pushers are held in position

FIGURE 5.—A MARTIN SWITCH OPENING THE CHARGING CURRENT OF A 22-MILE TRANSMISSION AT 30,000 VOLTS.

by springs, and when the switch is about to be thrown and the handle is pushed in and about to engage the releasing spring, these springs are pressed by the handle plate and are so adjusted as to force the switch bar out of the jaws at the instant it is released by the latch, the operating spring thus being called upon to simply carry the switch bar along the switch rods with sufficient speed to disrupt the arc, whereas, in the previous types it was

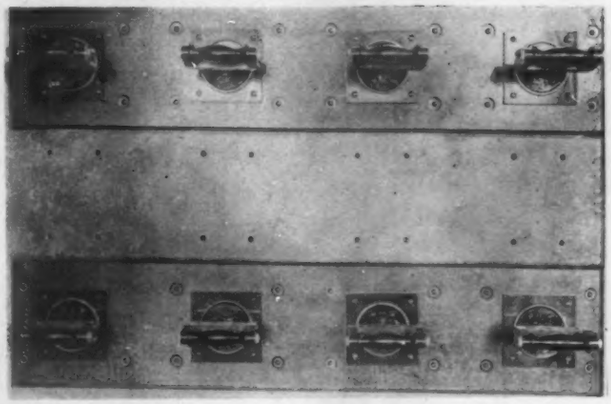


FIGURE 6.—A GANG OF SINGLE-POLE DOUBLE-BREAK 5000-VOLT MARTIN SWITCHES. FRONT VIEW, OPEN.

necessary for the operating spring to be strong enough to not only carry the switch bar, but also to release it from the jaws.

This final type of switch was developed about two years ago, and, after very severe tests in actual use and the installation of a great number, has not only proved itself to be a perfectly satisfactory switch under the most severe conditions, but has so far developed no weak points, and the writer believes has reached its final development, and as such can be considered as one of the most satisfactory switches for the purpose for which it was designed. The type "C" switch has two breaks of nine inches, or a total arcing distance of eighteen inches.

Some recent extensions of the 16,500-volt line of the Bay Counties Power Company have called for some switches similar to the original type "A" switch which was primarily designed for their plant, and for this purpose the type "D" switch, which, in brief, consists of the details developed in the type "C" switch, being placed upon the original type "A" switch, except that owing to the length of break of this switch, amounting to two 18-inch breaks, or a total of 36 inches, it was necessary to provide an outboard bearing. In place, however, of putting wrought iron brackets on each switch, as was done

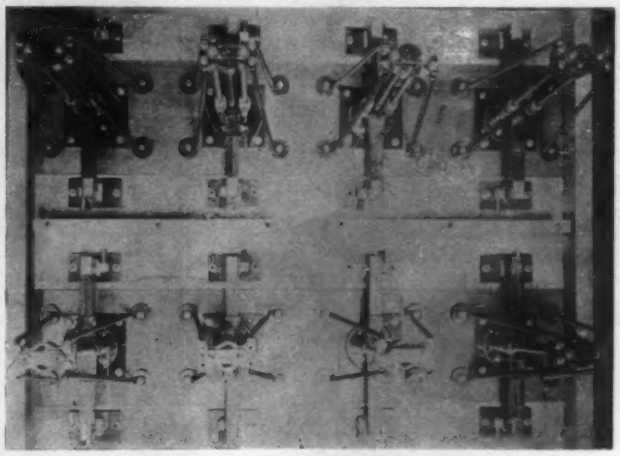


FIGURE 7.—A GANG OF SINGLE-POLE, DOUBLE-BREAK 5000-VOLT MARTIN SWITCHES. REAR VIEW, CLOSED.

in the case of the original switches, these outboard bearings are supported on a piece of hard wood running the length of each bank of three or four switches, as the case may be, and supported at the end in its proper position in either one of two ways, that is to say, either by a vertical wood support, which also can be considered as part of the frame used for supporting the busbars, or by a wrought-iron bracket which can be secured to the wood supporting frame of the switch.

The final commercial forms of this switch are those known as type "C" and type "D," being designed for 5,500 and 16,500 volts respectively. The preceding types have merely been mentioned for the purpose of showing the development of a switch which has been so largely used in power of transmission work in California. The details of the installation of the switch are very clearly shown in the photographs and drawings, and some of the advantages may be mentioned in closing.

This switch is believed to be one of the first high potential switches developed in which all the live parts and contacts were back of the board and away from the operator. The insulated handle, which is constructed of hard rubber and very carefully built, is designed as an extra precaution in case the main insulation of the switch should by any chance break down. The line terminals are mounted on hard rubber, and the hard rubber in turn secured to the marble. In this way the line terminals are thoroughly insulated from the marble, and the marble is not relied upon at all for insulation purposes, but rather as a non-combustible support for the terminals. The conductor in the switch bar is first insulated by being incased in soft rubber tubing and then placed between two heavy strips of hard fiber, in this way completely insulating the operating mechanism of the switch. As an additional protection to the operator, however, the

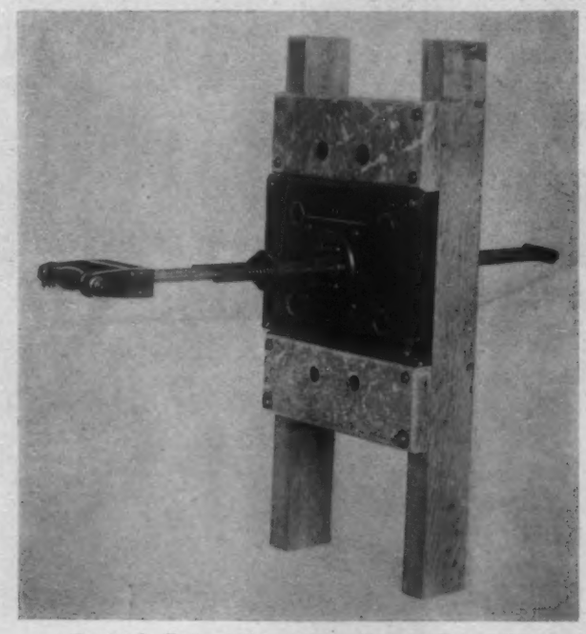


FIGURE 8.—THE 5500-VOLT MARTIN SWITCH, TYPE "C." FRONT VIEW, CLOSED.

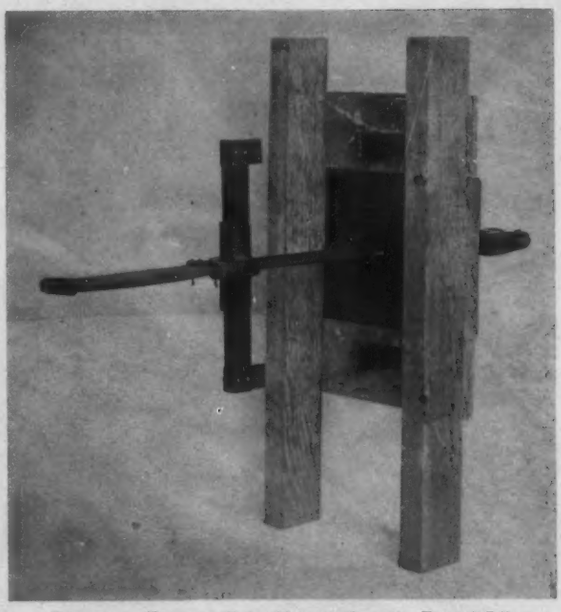


FIGURE 9.—THE 5500-VOLT MARTIN SWITCH, TYPE "C." REAR VIEW, OPEN.

insulated handle is placed on the switch rods. The switch rods and operating mechanism are mounted on and secured to two large hard rubber plates, which, in turn, are secured to the oak supporting panel, and as a result we may consider this switch as being not only perfectly insulated, but a particularly safe one to operate, and in the experience of nearly four years no instance has been reported of the insulation breaking down or any accident resulting from its operation, a record which is not only good, but also a particularly satisfactory one to its designers.

One criticism which has been made from time to time has been with reference to the space occupied by this switch, particularly in the case of the 16,500-volt or type "D" switch, and all that the designers can say in reply is that they consider that the increased space called for by this switch seems but a small price to pay for ease and safety of operation and insulation provided by the switch. It is essentially a quick break switch, and as such has all the advantages which pertain to such a switch, and the success of the switch is largely due to this fact.

These switches can also be operated in pairs, in this way making a double pole, double break switch. The method of doing this is by connecting two switches by means of an insulating hard wood connecting piece which is attached to the switch rods of two switches in place of the handles, a handle being placed in the center of the switch for the purpose of operation.

AN UNTOLD TALE.

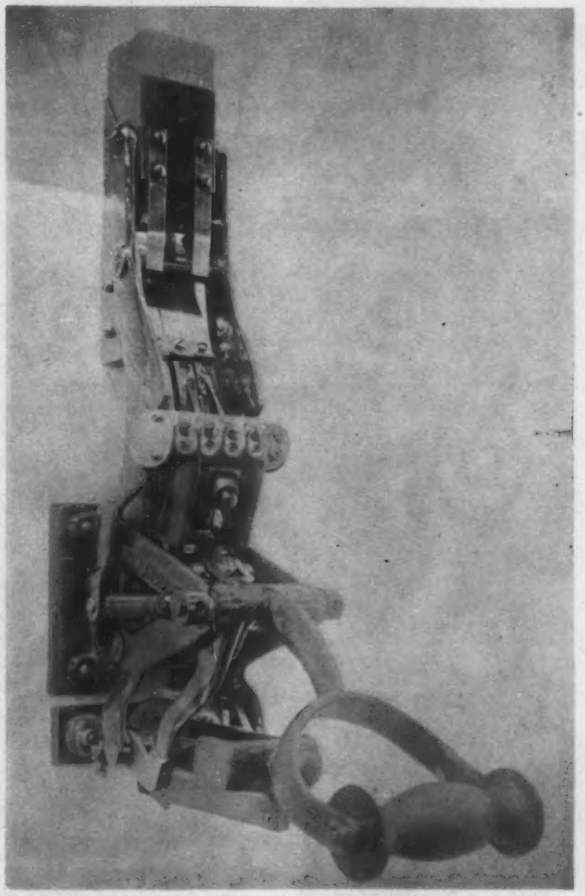
The manager of a transmission plant having a capacity of over 3,000 horse-power, in replying to a letter of inquiry concerning the use of high tension switches in his system, writes:

"We have the bummest layout of high tension switches imaginable, and we are not able to break any quantity of current at high potentials. We expect to have an up-to-date high-tension switchboard completed inside of a year, but for the present our tale had better remain untold."

THE LATEST WESTINGHOUSE TYPES.*

BY W. M. McFARLAND.

CIRCUIT opening devices are constructed on the general principle employing the open arc and carbon break. This is obviously the most simple type of apparatus, and one in which the extinction of the arc depends simply on mechanical distance and not upon the character of materials used in constructing the apparatus. Whenever an arc is confined it must necessarily have a deteriorating effect upon the materials with which it comes in contact. When the currents are heavy or voltages are high, it is obvious that very great responsibility is placed upon the integrity of the materials composing the switch.



750-VOLT, 1500-AMPERE, A.-C. AND D.-C. CIRCUIT BREAKER.

The fundamental principles underlying the high voltage circuit-breakers about to be described, which are those of the Westinghouse Electric and Manufacturing Company, is, therefore, a rational and correct one.

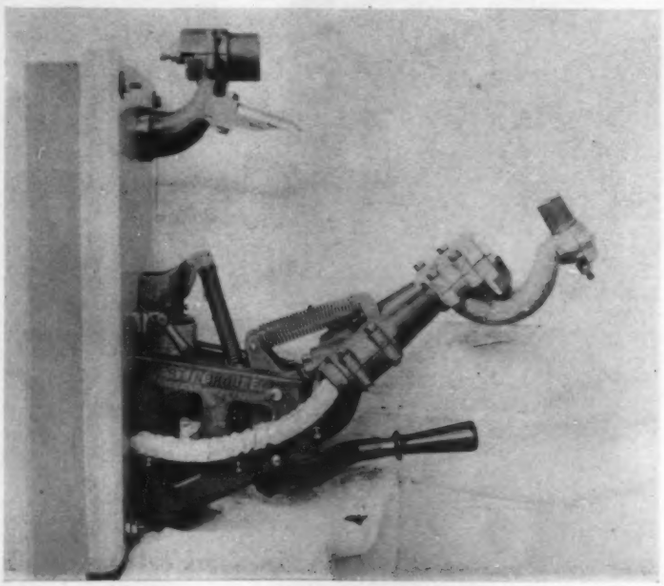
The Westinghouse 750-volt, 1500-ampere alternating current and direct current circuit-breakers are strong and simple in construction and of neat design. The arcing and current-carrying contacts are in plain view, a most important feature, allowing the attendant to see at a glance the condition of the working parts. The essential parts of these breakers are the laminated copper brush, the swinging arm, the contact blocks, and the carbon shunts at the top. The break takes place on carbon terminals well removed from the metal parts of the circuit-breaker. The length of the break is proportional to the voltage for which the circuit-breaker is designed.

These circuit-breakers will carry their full-rated current with a rise in temperature not exceeding 20° C. They will successfully open the circuit in which they are connected under any condition of overload or short circuit. They are made in one, two, three and four-pole combinations. Each element of the set is provided with an automatic tripping coil, which acts independently of the others. In the two, three, and four-pole combinations, attachments are provided whereby all the elements can be closed together and tripped simultaneously. Barriers of marble are placed, when necessary, between adjacent breakers to prevent the arcs communicating.

The 2200-volt, 1000-ampere circuit-breaker has been designed to meet the requirements for a reliable automatic circuit-breaker for moderately high potential circuits, carrying heavy currents. The contact surfaces are ample and the contact is made by laminated copper brushes against a flat copper block. The contact pressure of this brush is sufficient to help the releasing spring throw out the movable arm of the circuit-breaker when it is tripped. This is a very important feature on heavy currents.

The current-carrying contact of these circuit-breakers are protected by copper shunts, so that, when the breaker is opened, the current is gradually shunted from the current-carrying contacts to the carbons by steps of such low resistance that no arcing can occur until the final break is made on the carbons. This feature in the design of these circuit-breakers obviates all possibility of "bugging" of the copper, or current-carrying contacts.

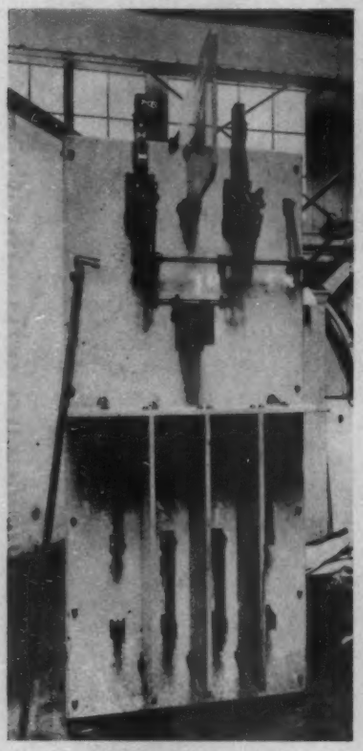
The length of break, or opening of the circuit-breakers, is proportioned to the voltage of the circuit. The arc occurs on carbon terminals above, and well removed from



2200-VOLT, 1000-AMPERE, CIRCUIT BREAKER, OPEN.

*Submitted for discussion at the Fifth Annual Convention of the Pacific Coast Electric Transmission Association, San Jose, Cal., June 18-19, 1901.

the metal parts of the breaker. The construction of the circuit-breakers aids the natural tendency of the arc to rise and prevents any possibility of communication to any live parts below the carbon terminals.



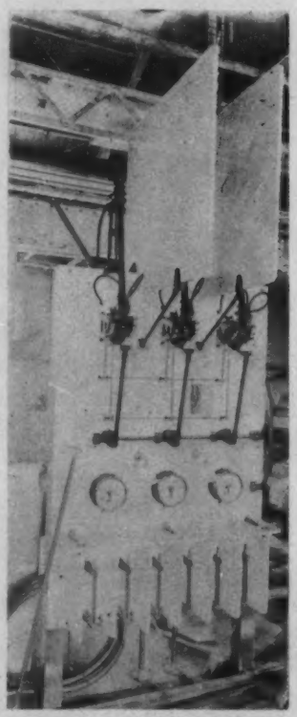
2200-VOLT PANEL WITH CIRCUIT BREAKERS AND HOOK-TYPE SWITCHES.

A 2200-volt panel with circuit-breakers and hook-type switches is shown in the accompanying engraving. The circuit-breakers thereon are similar in construction and design to the 750-volt circuit-breaker described above, and are arranged to be simultaneously closed. In large plants there are always some circuits in the distributing system which should not be opened by every short circuit or overload that occurs on them, but only when such occurrences assume dangerous proportions. On this panel is shown an attachment called a time-limit relay, which is attached to the trigger of the circuit-breakers.

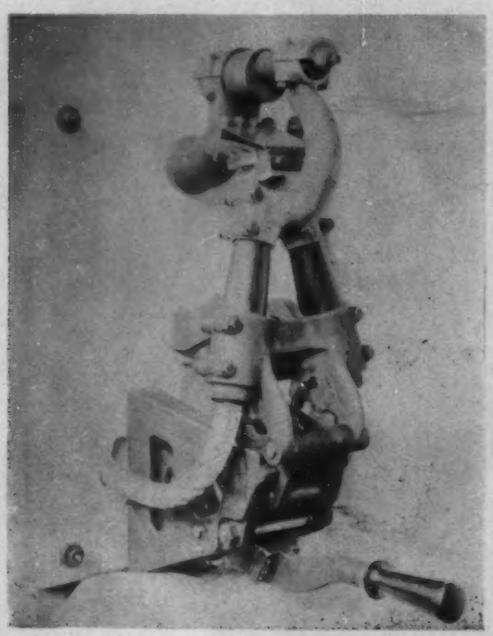
This time-limit relay is a spring motor which can be set so that it will not allow the circuit-breaker to open unless the overload continues for a pre-determined time, between one and ten seconds—the limits of the relay. Should the overload continue to the expiration of the time for which the relay is set, the trigger is unlocked and the circuit-breaker opens. If the short circuit or overload ceases before the time for which the relay is set, the releasing trigger falls back and the relay resets itself.

The switches are accurately finished and make perfect contact. As shown they are of bare copper and separated from each other and the remainder of the board by marble barriers. This type of switch is operated by the hook and rod shown.

The 11,000-volt circuit-breaker and time-limit relay-feeder panel is similar to the one above, with the necessary modifications to adapt it to the higher potential. The time-limit relay is connected to all three circuit-breakers as shown, as is also the resetting handles, so that the operation of the breakers is at all times simultaneous. An overload or short circuit on any phase starts the relay, and at the end of the allotted time, all the breakers are thrown out, and not merely those on the phase in trouble. An ampere meter is, of course, included in each circuit. The hooks, which, while essentially the same as for lower voltage, is more perfectly mounted and insulated.

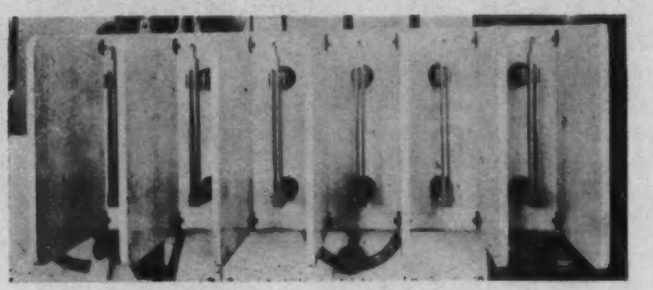


11,000-VOLT CIRCUIT BREAKER AND TIME LIMIT RELAY FEEDER PANEL.



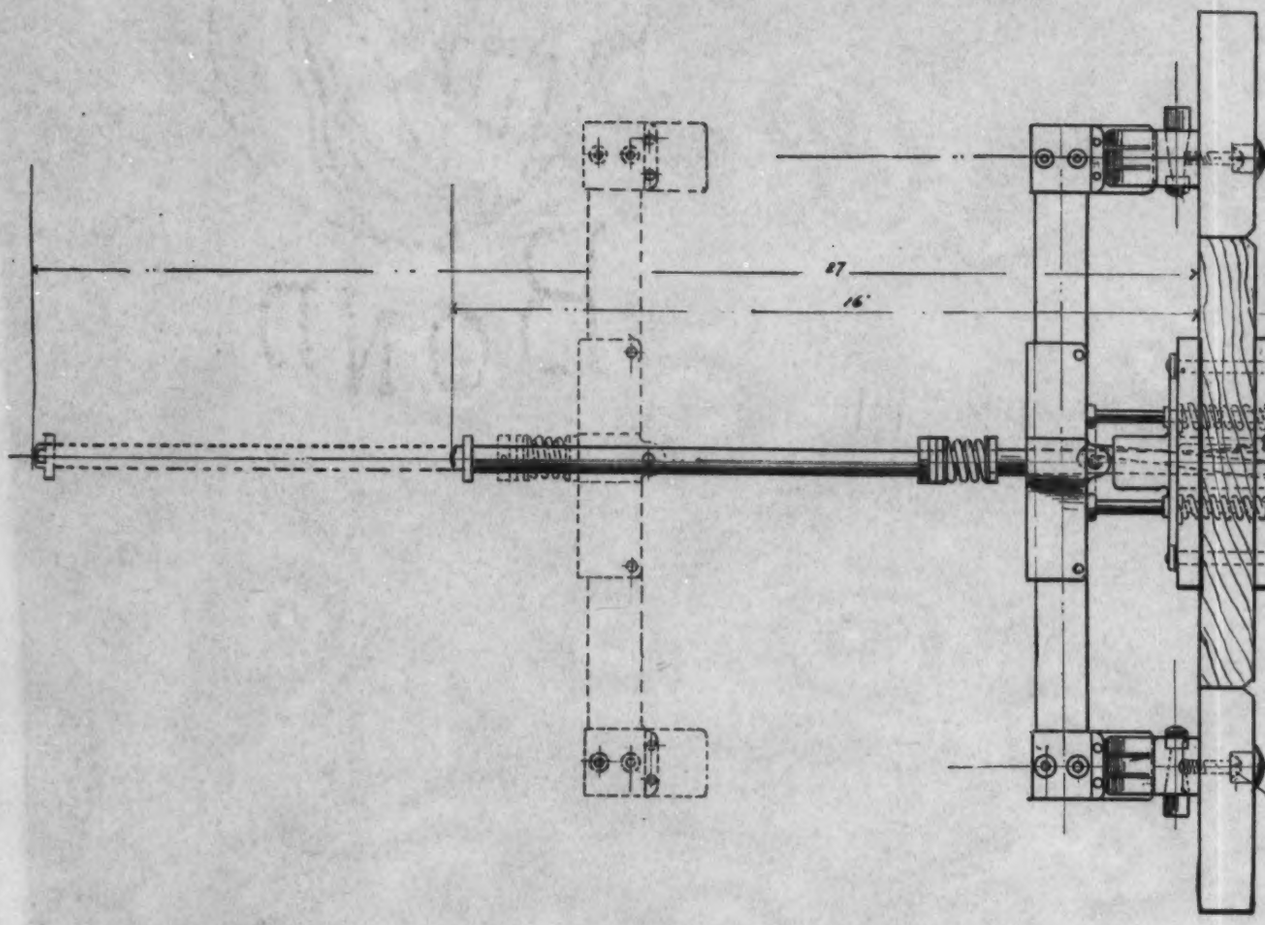
2200-VOLT, 1000-AMPERE, CIRCUIT BREAKER, CLOSED.

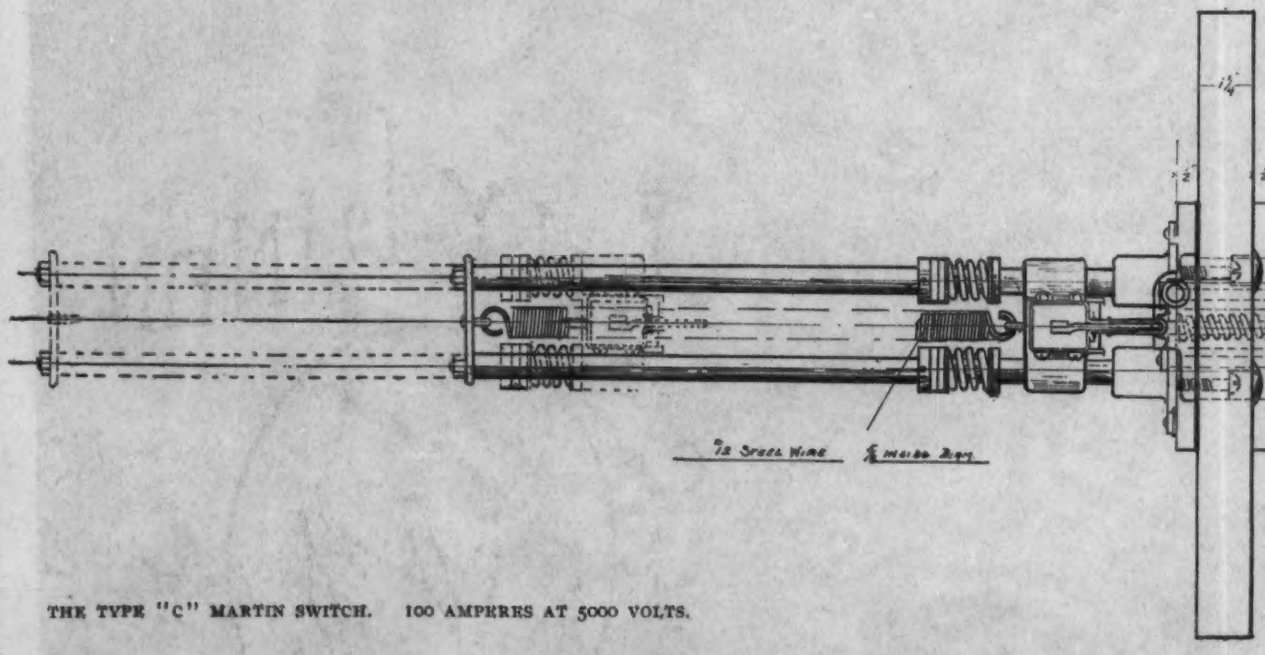
The 11,000-volt hook-type switches of the Westinghouse Electric Company form a breaker that is similar in general to the one second above described, but is suitably proportioned for a higher voltage.



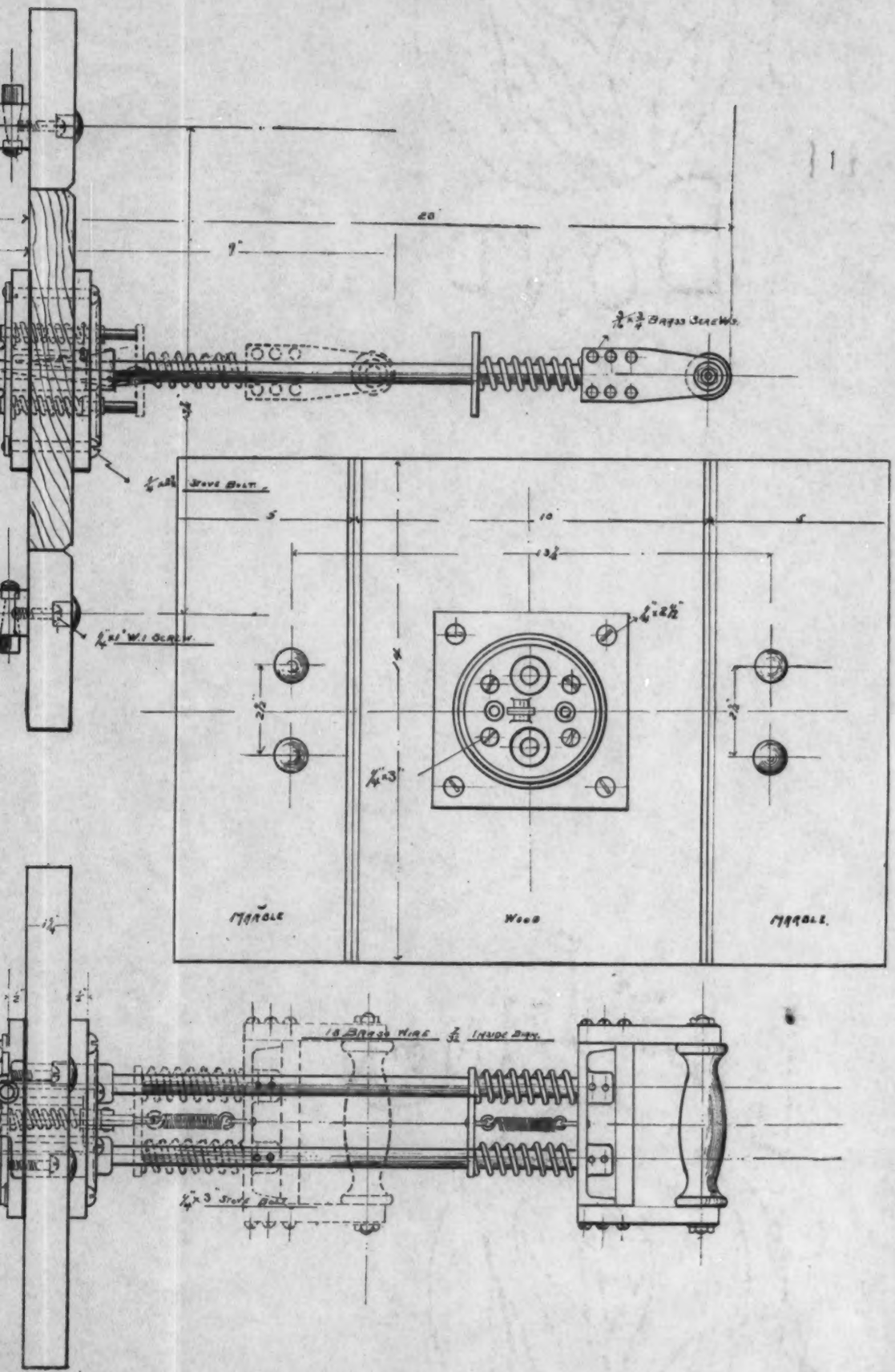
11,000-VOLT HOOK-TYPE SWITCHES.

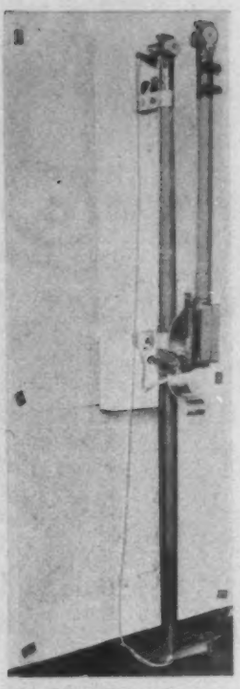
The accompanying fused circuit-breakers are designed for potentials from 6000 to 40,000 volts. As shown, the circuit-breaker consists of two hardwood poles, one being longer than the other, mounted upon a marble base, to which are secured the terminals to which the main leads



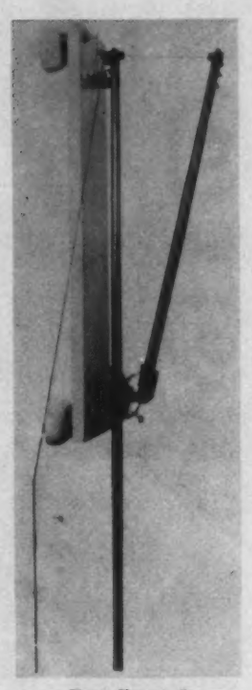


THE TYPE "C" MARTIN SWITCH. 100 AMPERES AT 5000 VOLTS.


20
9"
Brass Screws
Screw Bolts
10
MARBLE
WOOD
MARBLE.
Brass Wire
Screw Bolts



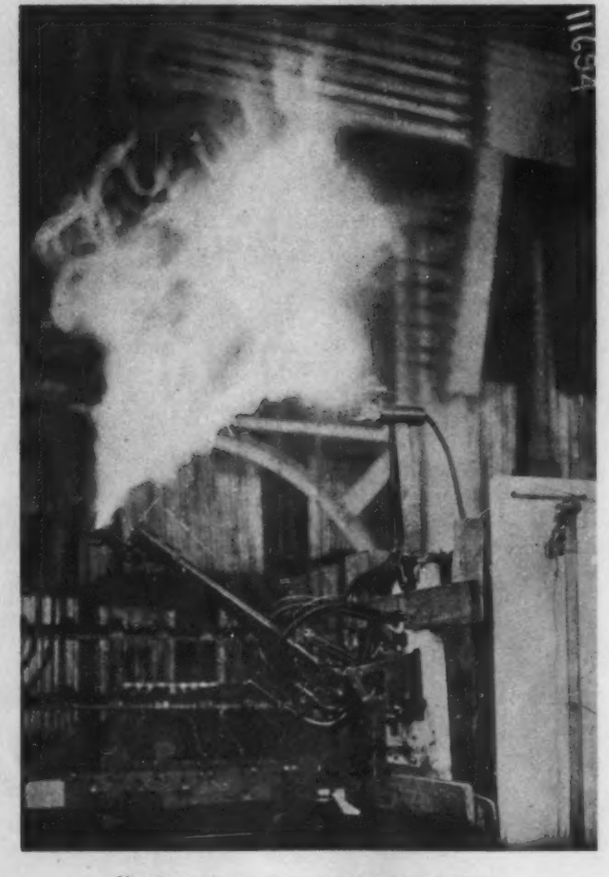
6000-VOLT FUSED CIRCUIT BREAKER.



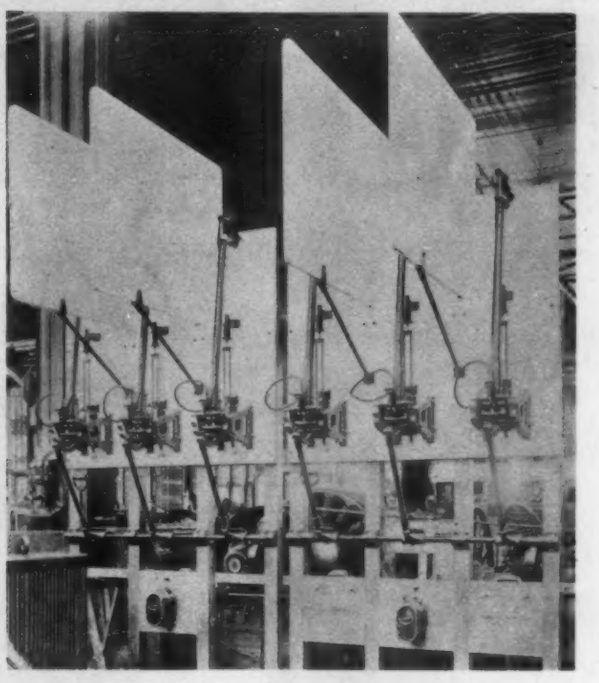
40,000-VOLT FUSED CIRCUIT BREAKER.

or wires are connected. The poles are connected by a hinge, so that their extremities are in line at the upper end. On the upper end of each pole is mounted a copper sleeve, supporting a round carbon contact block with a hole through its center. The longer pole is provided with spring jaws or clips so that it may be quickly and easily attached to, or detached from, the terminals on the marble base. The short pole has a flexible wire running through its interior; this wire is connected to the copper sleeve at the upper end of the short pole and to the lower clip terminal on the long pole. The sleeve at the upper end of the long pole is connected to the upper clip terminal. Thus, these connections practically make the sleeves at the upper end of the two poles the terminals of the apparatus.

The poles being removed from the base, a wire is inserted through the hole in the carbon tip at the upper end of the short pole and secured to the copper sleeve by a screw and washer. The other end of the fuse is passed through the carbon tip on the long pole and secured to the copper sleev. by a cam-shaped lock. The length of the fuse should be from six to ten inches.



6600-VOLT CIRCUIT BREAKER OPENING CIRCUIT.



22,000-VOLT CIRCUIT BREAKER AND REVERSE CURRENT RELAY.

The poles, after being fused, are placed in position by taking hold of the lower end of the long pole. When the fuse blows the short pole is released by the action of the spring at the lower end and falls away from the stationary pole, thus making a very long break. The lock cam has a long string attached to it, by means of which the fuse can be released, if desired, thus causing the short pole to drop in the same manner as when the fuse blows. This feature permits the device to be used as a switch.

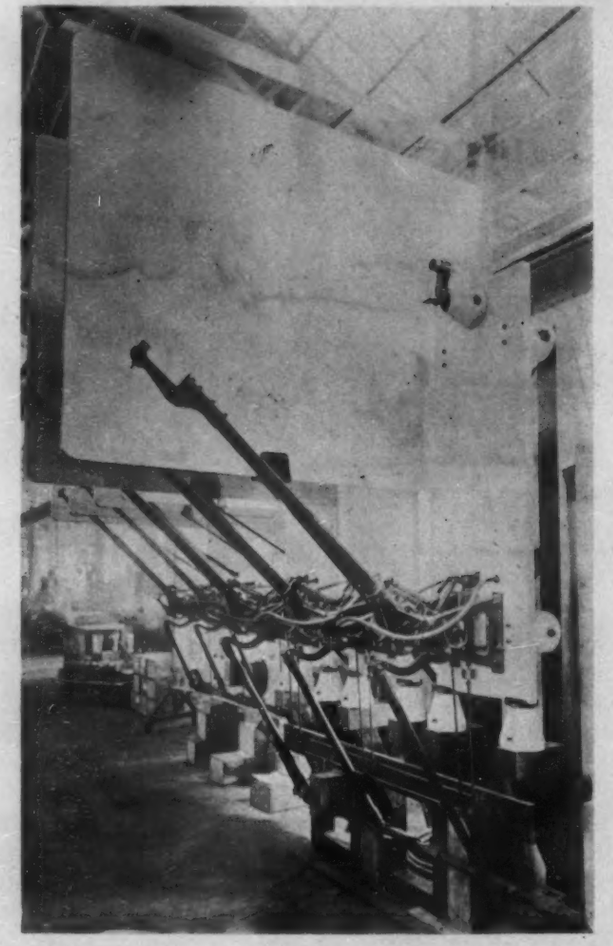
These circuit-breakers are light, simple, easily removed or replaced, quickly fused, reliable, and can be operated with the utmost safety.

The accompanying photograph, which is of a 6600-

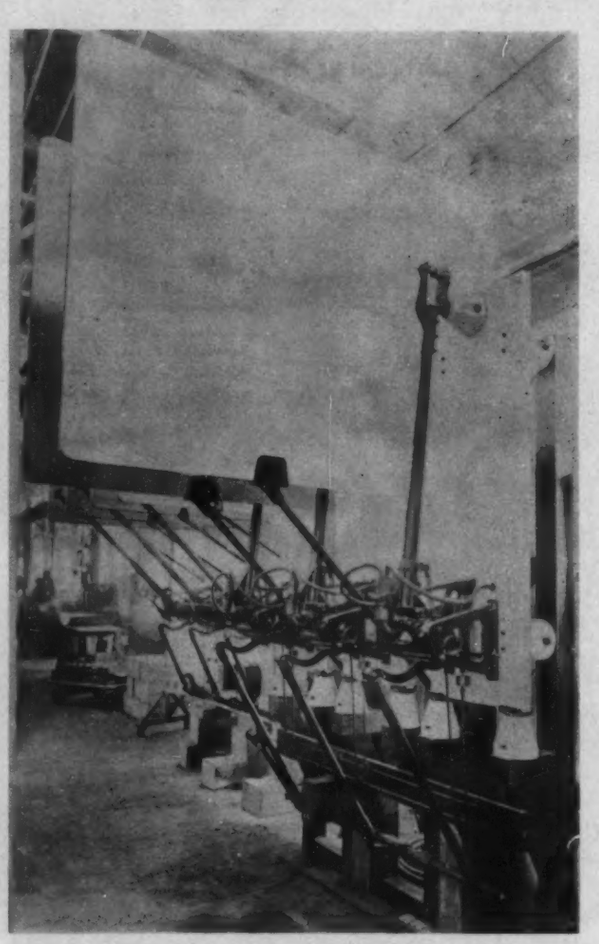
volt circuit-breaker opening a circuit, shows the satisfactory operation of this class of circuit-breakers. The design of this breaker is very similar to that of the 2200-volt, 1000-ampere one described above, with suitable modifications for higher voltage and smaller circuit. The illustration shows very clearly how the arc is forced upwards and finally extinguished by the upward rush of air. It also shows how all the destructive effects are confined to the carbon rods, or final breaking point of the circuit.

The 22,000-volt circuit-breaker and reverse-current relay shown are of the same design as in the last illustration, but modified, of course, to handle the high potential of 22,000 volts. The tripping of the breakers, however, is not only caused by overload as in the usual manner, but also by a reversal of the current in reference to the voltage in the same circuit. The device for controlling this operation is called the "Reverse-Current Relay" and appears in the middle of the lower panel.

The 25,000-volt circuit-breakers are of the same type as shown in the last illustration, increasing in length of arm and length of opening with each increase of voltage. The large marble barriers and the insulators on which the marble and terminals are mounted indicate the care and attention that is paid to all details of these breakers.



25,000-VOLT CIRCUIT BREAKER, OPEN.



25,000-VOLT CIRCUIT BREAKER, CLOSED.

BREAKS 800 KILOWATTS AT 15,000 VOLTS.

BY LEM S. BOGGS.

A STANDARD high tension switch and circuit breaker was recently installed by Sargent & Lundy, as consulting engineers, for the Union Traction Company, of Indiana. This is a street railway installation throughout, which develops power at a central steam station, whence it is transmitted at 16,000 volts to eight substations for connecting three-phase current to direct current for railway work.

Westinghouse stick type high tension circuit-breakers are used, and while I have not seen them break more than 800 kilowatts at 16,000 volts, it does this admirably and with no bad results at all. It makes a nice, good, clean break at all times.

The high tension boards at the power house and the various substations are like the drawings herewith, which are self-explanatory.

AN AIR-BLAST SWITCH.

One of the Helios three-phase generators at the Paris Exposition was equipped with a combined switch-gear and automatic breaker,* which is novel in that it utilizes an air-blast to blow out the arc on opening the circuit. The air is supplied at a pressure of 20 atmospheres.

W. J. Jenks, New York, writes: "I have examined with great interest the Snoqualmie edition of THE JOURNAL, which I regularly bind for permanent preservation. . . . . You must have an exceptionally clear atmosphere and also an exceptionally good artist."

* *Science Abstracts*, No. 705, for 1901.

THE LATEST STANLEY TYPES.*

BY W. CURRIE.

REGARDING the high-tension switches manufactured by the Stanley Electric Manufacturing Company, a few preliminary remarks may be made. In the manufacture of this class of work, it has always been the company's object to keep in view these principles of design:

First—That the switch will permit of the manipulation of the circuits freely and quickly with perfect safety to life and property.

Second—That all arcs formed shall be thoroughly ruptured.

Third—That any repairs can be done with the least expense of time and labor.

From the descriptions of such apparatus given below, it will be seen that the above principles have been followed out thoroughly, leaving nothing undone that will help along the successful operation of the switch.

With regard to the operation of such apparatus, it has always been the policy of the company to test thoroughly under all conditions all apparatus before leaving the factory. As ample means for these tests have been provided in the factory, the company is safe in saying that its high-tension apparatus will perform all the duties claimed for it, thoroughly and completely.

The principles embodied in the design of both switch and circuit breaker are practically the same, the circuit breaker being a slide switch with a coil and tripping device placed on it so as to open the switch automatically. The circuit breaker can also be opened in a similar manner as the slide switch, thus ensuring a positive means of breaking the circuit, if any trouble should occur due to the coil which operates the tripping device not acting.

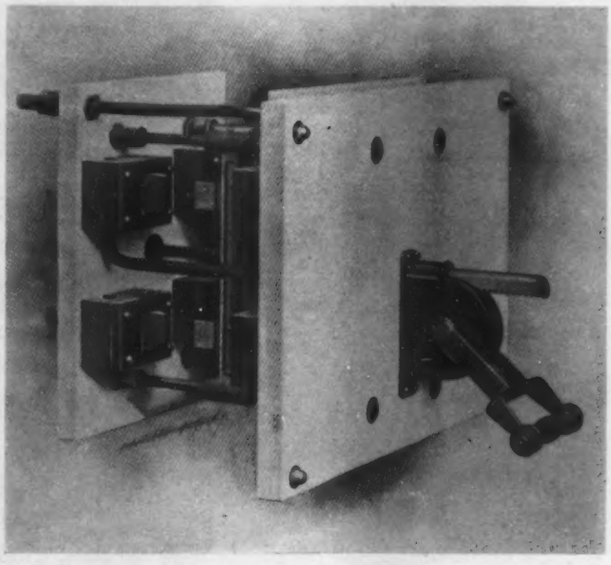


FIGURE 1.—DOUBLE-POLE, DOUBLE-THROW, SLIDE SWITCH, FRONT VIEW.

*Submitted for discussion at the Fifth Annual Convention of the Pacific Coast Electric Transmission Association, San Jose, Cal., June 18-19, 1901.

The accompanying photographs (Figures 1 and 2) show front and back views of the double pole double throw slide switch, and the general remarks given below apply to both switch and circuit breaker alike. From the photographs it is seen that all the working parts are on the back of the marble board, easily accessible and open to view, thus allowing all parts to be kept in good order at the least expense of time and labor. The knife blades are made to slide on parallel rods which serve to support the front and back terminal marbles to the main marble or switchboard and which also guide the blades into the terminal jaw contacts. These blades are thoroughly insulated from the guide rods and are moved back and forth by means of a pull rod which projects through to the front of the board, the pull rod being operated by a rack and pinion on the main marble. Each terminal jaw contact piece is enclosed in a separate insulated box, provided with a shutter, which closes quickly by means of a spring immediately after the blade has been pulled away from the contacts, and thus any arc that may be formed is ruptured. Quick operation and sharp snap break is obtained by means of a spring placed on the main pull rod.

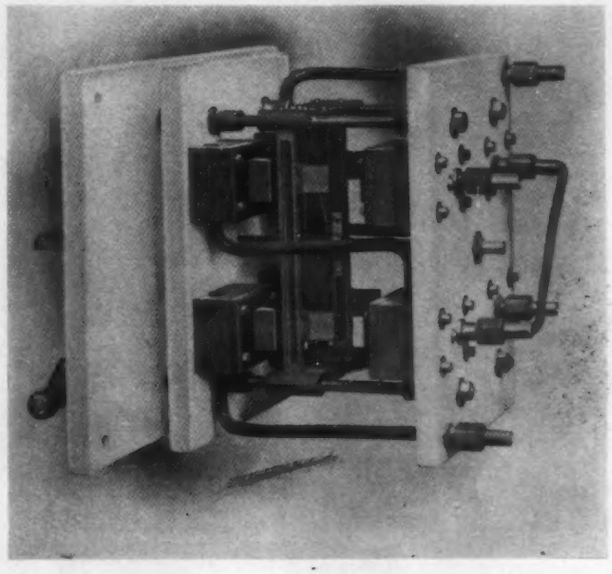


FIGURE 2.—DOUBLE-POLE, DOUBLE-THROW, SLIDE SWITCH, BACK VIEW.

These switches and circuit breakers are built for the following standard capacities and voltages:

300	amperes	at	1,200	volts.
200	"	"	2,400	"
60	"	"	6,600	"

Below 3000 volts, the switch is designed with two breaks per pole, while above 3000 volts there are four breaks per pole.

The principle covered in the design of the Stanley oil switches is that on breaking the contact between knife blade and jaw, an insulating fluid, such as oil, is allowed to rush in quickly between jaw and blade, insulating

them thoroughly from each other and breaking any arc that may be formed.

The accompanying photograph (Figure 3) shows the general outline of a two-pole single throw oil switch, set up ready for operation. Each pole of the switch, consisting of knife blade and terminal jaws, is immersed in oil

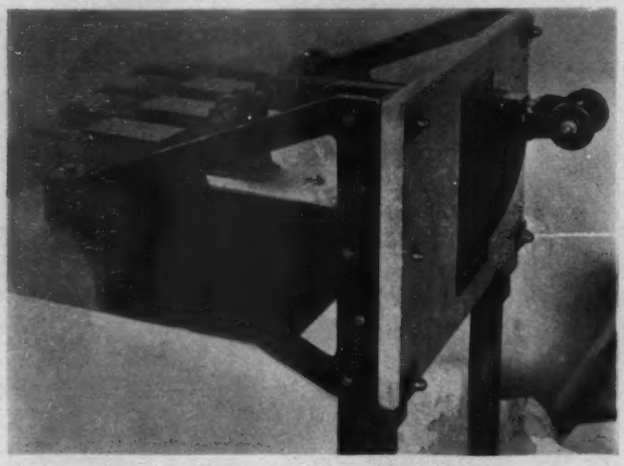


FIGURE 3.—DOUBLE-POLE, SINGLE-THROW, STANLEY OIL SWITCH.

in a separate cast-iron porcelain-lined tank. These tanks are then mounted on a piece of marble forming the cover for the tanks and on top of which are placed the terminals and mechanical apparatus for the proper operation of the switch. This top marble is mounted on framework at the back of the board and is entirely separate from the front marble of the main switchboard, the only part visible on the front of the board being the operating handle, which is thoroughly insulated from the working parts of the switch, thus avoiding any chance of danger to the operator.

The tanks are easily detachable from their top marbles, leaving the working parts easy of access, while the blades and contacts are tipped with detachable pieces, thus allowing any mechanical or electrical repairs to be made with the least possible expense of time and labor and thereby keeping the switch always in the best possible repair and working order.

In order to avoid all possible chance of anything coming in contact with the live terminals of the switch, the terminal leads are either brought out through porcelain tubes inserted in the top marble (for voltages higher than 4500 volts), or are brought out to metal terminals mounted on the top marble which are enclosed in wooden insulating boxes (for voltages lower than 4500 volts).

These oil types of switch are built for the following standard capacities and voltages:

1000	amperes	at	2,400	volts.
500	"	"	4,400	"
100	"	"	7,500	"
100	"	"	12,000	"

For voltages above 4500 volts, the switch is made with four breaks per pole, while below 4500 volts there are only two breaks per pole.

The plug type of switch depends for its successful operation on the mechanical separation of a receptacle from its terminal plug, quickly and sharply—the arc formed, due to the breaking of the contact, being ruptured in the air on account of the quickness of motion and the distance of separation. The accompanying photograph (Figure 4) shows the general outline and design of a single pole double throw switch ready for operation. The terminals are mounted on the marble switchboard and are thoroughly insulated from it by means of rubber bushings and porcelains, designed so as to get a large creeping area between terminal and board, thus avoiding any danger of leakage from terminals to marble.

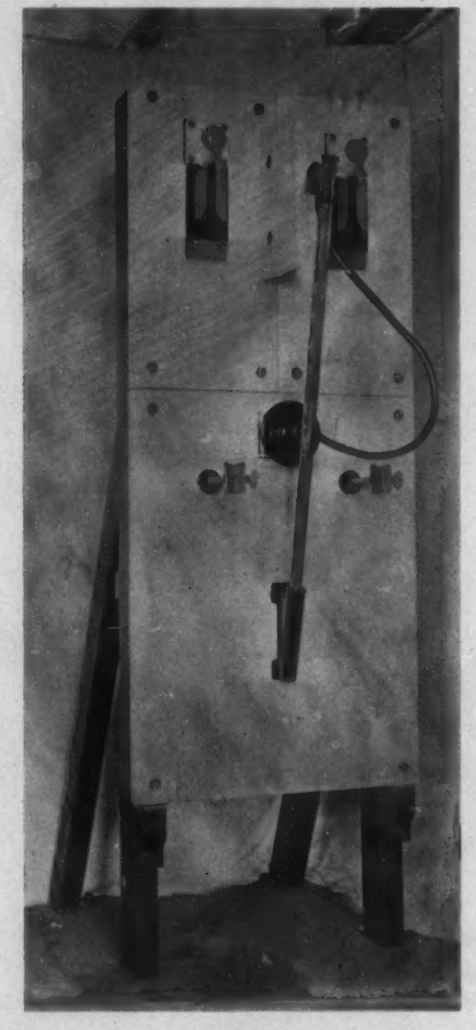


FIGURE 4.—THE STANLEY SINGLE-POLE, DOUBLE-THROW, PLUG-TYPE SWITCH.

The upper terminal consists of a metal plug bent in fashion shown and tipped with detachable metal tips, while the lower terminal, which is inserted well into the marble to avoid any danger of contact, consists of an ordinary straight terminal plug, the terminal plug being

tapered and ground to fit the contact pieces and form good contact surface.

Electrical connection between the two terminals is made by means of two contact pieces connected by a piece of high voltage cable. The upper contact piece consists of a metal receptacle, tipped with a detachable metal piece and having cast on it a metal projection which fits into a hard rubber guide plate that is placed on the front of the switchboard; the receptacle and projection being mounted on a hard wood handle. By this guiding device, all danger of breaking or bending the terminal plug, due to carelessness or quick handling is avoided and a straight line motion between plug and receptacle is insured.

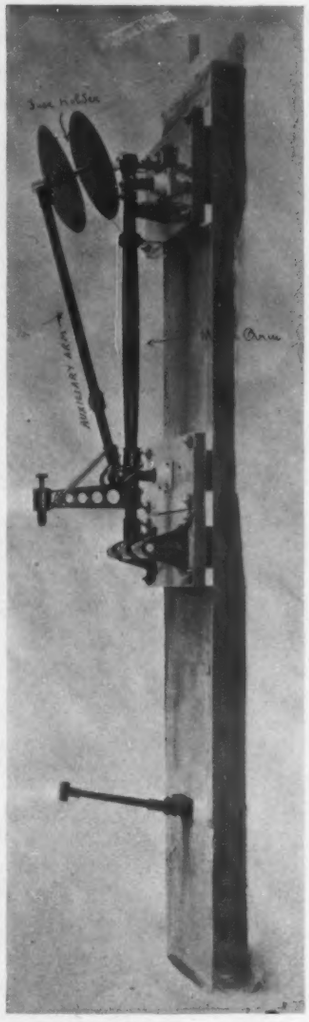


FIGURE 5.—THE STANLEY SINGLE-POLE, SINGLE-THROW COMBINATION FUSE AND SWITCH READY FOR OPERATION.

The lower contact piece consists of a metal receptacle surrounded by a hard rubber handle on which is mounted a hard rubber guard for the hand. There is also a locking device on this receptacle to avoid any chance of the circuit being broken at this point, as the upper terminal is the one designed for this purpose. The switch is operated by loosening the upper receptacle from the plug and pulling it quickly away, thus breaking the arc. The lower receptacle is then unlocked and taken out, leaving the whole board free from danger to the operator.

When these switches are used on voltages of 12,000 volts and over, an extra percaution is taken for safety by boiling the wooden frame and marble in paraffine, insulating the bolts holding marble to the frame with rubber, and placing a hard rubber tube over the wooden handle.

These switches are built for the following standard capacities and voltages:

75	amperes at	6,600	volts.
50	" "	12,000	"
35	" "	20,000	"
25	" "	30,000	"

This type of switch, known as the combination fuse and switch, depends for its successful operation on the drawing of a metal fuse through a non-conducting powder, which is enclosed in a short insulated tube. The arc formed, due to the breaking of contacts, is ruptured as the fuse passes quickly through the powder. The accompanying photographs (Figures 5, 6 and 7 respectively) show the general design of a single pole single throw switch (1) set up ready for operation, (2) with fuse blown, and (3) in position ready to fuse. The combination consists of a main arm, an auxiliary arm, a fuse and fuse holder, and the two terminal jaws, together with the mechanical details for the proper operation of the switch. The main arm consists of a wooden rod, hinged at the bottom and having mounted on the top two zinc jaws, which are used for holding one end of the fuse. On this main arm

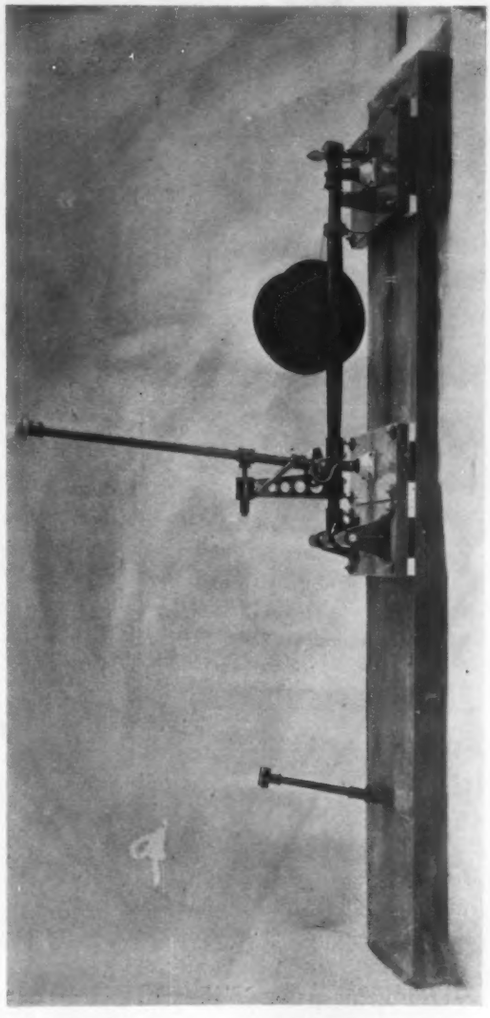


FIGURE 6.—THE STANLEY SINGLE-POLE, SINGLE-THROW COMBINATION FUSE AND SWITCH WITH FUSE BLOWN.

are also mounted two blades for making the contact between the main arm and the terminal jaws. The upper blade is electrically connected to the two zinc jaws, while the lower blade is connected to the auxiliary arm by means of a cable.

As the circuit is never intended to be broken between the terminal jaw and blade, but by allowing the fuse to slip from the zinc jaws, the main arm is locked in its upright position and cannot be unlocked until the auxiliary arm has dropped into a horizontal position, thus breaking the circuit, which is done by means of an insulated rod running up through the center of main arm.

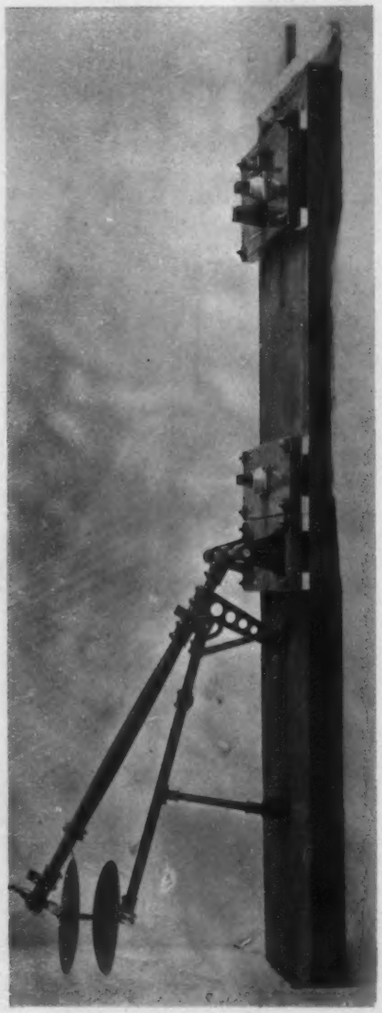


FIGURE 7.—THE STANLEY SINGLE-POLE, SINGLE-THROW COMBINATION FUSE AND SWITCH IN POSITION READY TO FUSE.

The auxiliary arm consists of a hollow wooden rod hinged to the main arm at the bottom and having mounted on the top two zinc plates forming the holding device for the other end of the fuse. Inside the wooden arm is a copper rod used to form the connection between the plates and the lower blade on the main arm. This auxiliary arm is pulled sharply away by means of a spring and the jar caused by the arm falling is taken up by the dashpot on a bracket attacked to the main arm.

The fuse holder consists of a hollow insulated tube having perforated corks and large washers at each end and containing the non-conducting, non-fusible powder through which the fuse is drawn. It is also tied to the main arm so as to keep it from falling to the ground after the circuit is broken. The fuse, enclosed in the fuse-holder, is held in position between the main arm and the auxiliary arm by means of the zinc jaws on the top end of the main arm and the zinc plates on the auxiliary arm. The jaws forming the terminals are mounted on separate pieces of marble and are thoroughly insulated by means of porcelains and bushings so as to avoid any leakage to the marble. On the upper terminal marble is also mounted a catch used for opening the zinc jaws on main arm by means of a rope and pulley, and thus releasing the fuse.

Figure 5 shows the switch in its normal position, the current coming in at the upper terminal, thence passing to zinc jaws on main arm, then through the fuse to the auxiliary arm, then down the auxiliary arm to the lower blade on the main arm, and thence through lower terminal out.

To open the switch, the rope attached to the catch is pulled down sufficiently to open the jaws and release one end of the fuse, which, on being released, is pulled rapidly through the non-conducting powder in the fuse-holder by the auxiliary arm, which falls into a horizontal position, thus breaking the circuit and rupturing the arc. The main arm is now unlocked from the catch by means of a long rod and the whole combination is allowed to swing down into a position where easy access can be had to the working parts, thus enabling the resetting of the fuse. After the fuse has been reset the whole combination is brought into its normal position by a rope attached to the main arm.

As the combination is primarily a switch and not a fuse, the fuse is made sufficiently heavy so as to avoid its blowing under anything but extreme conditions. If, on any account, the fuse should blow, the action is precisely the same as in the switch, except that the break takes place in the center of the tube instead of at the jaws.

These switches are built for any voltage from 10,000 to 60,000 volts, or even higher. They are in use on the 40,000-volt circuits of the Standard Electric Company of California and the Bay Counties Power Company.

SWITCHES ARE NOT OPENED UNDER "SHORTS."*

BY MAX HEBGEN.

MUCH as I should like to do so, I am not in a position to contribute anything regarding the experience of the Montana Power Transmission Company with high tension switches, for the simple reason that we have had no experience in that direction. We are using the ordinary high tension switch made by the General Electric Company for this work on our 16,000-volt transmission line from the Big Hole River to Butte, a distance of 22 miles, nevertheless we never open them under short circuits or troubles. We use them only for breaking the charging current of the line and for changing transformers from one line to another.

In case of trouble on the line such as short circuits and breaks, we make no attempt to open any switches, but allow the machines to burn off the short or trouble if possible, and if not, then we shut down and clear off the trouble.

Personally, I believe in oil switches. We are using them up to two thousand volts, and in my opinion they will in time be the only style of switch used in high tension work. Furthermore, I think it is only a question of a short time when they will be used to the exclusion of every other variety.

*Submitted for discussion at the Fifth Annual Convention of the Pacific Coast Electric Transmission Association, San Jose, Cal., June 18-19, 1901.

THE LATEST GENERAL ELECTRIC TYPES.*

BY H. C. WIRT.

THE opening of high-volt alternating current circuits of large kilowatt capacity is a serious problem to the station manager and engineer, especially if a liberal space has not been provided for the switching devices. To meet these conditions the General Electric Company has developed a line of oil switches and expulsion circuit breakers, which are in extensive use and are giving universal satisfaction.

The oil switches are made in the following forms:

Form "I" is an oil switch made for use on motor circuits up to a maximum of 3000 volts and 75 amperes capacity. It is made in double and triple pole and in single and double throw types for mounting on panel boards, skeleton boards or directly on the wall; the latter mounting being shown in the photograph reproduced in Figure S1 and 1A.

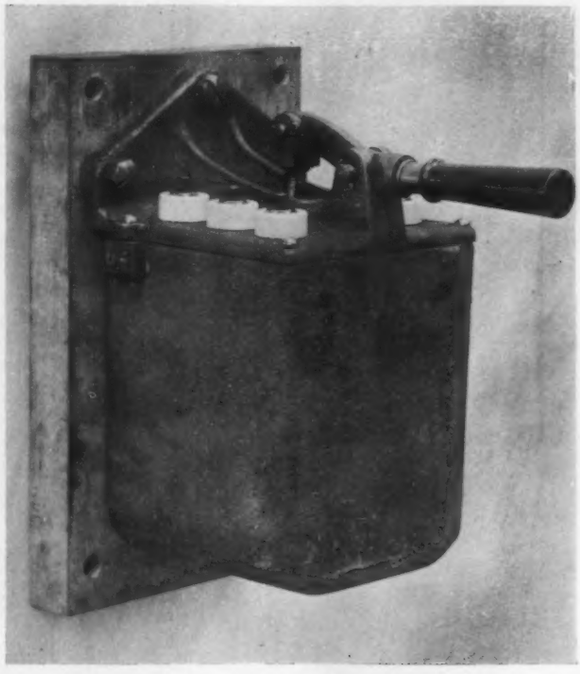


FIGURE 1.

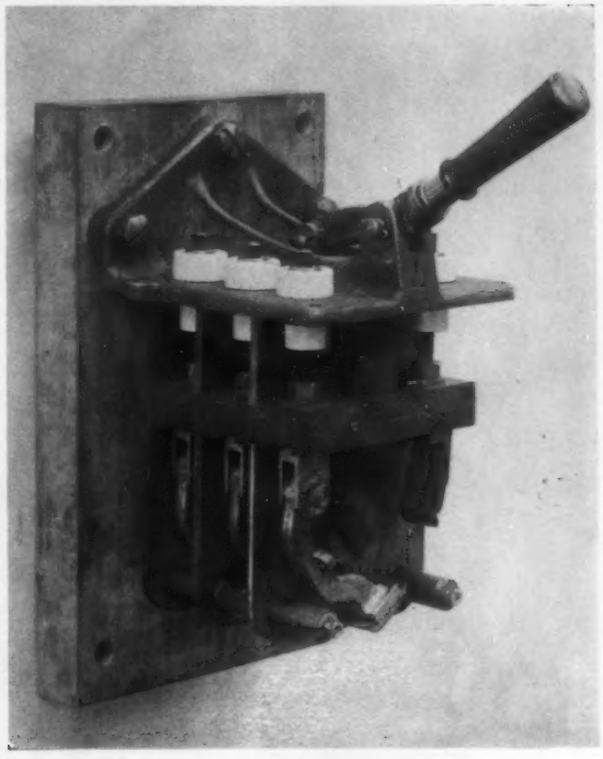


FIGURE 1A.

The form "K" switches are made for circuits of 15,000 volts and 100 amperes, 10,000 volts and 300 amperes, 5000 volts and 750 amperes and 3000 volts and 1500 amperes. These switches are made to be closed and opened by hand (Figures 2) and to be closed by hand and opened automatically (Figures 3 and 4). For the automatic tripping, two series transformers are used on a three-phase circuit, the secondaries of the transformers being connected to the two trip coils. These switches may be mounted directly on a panel and operated

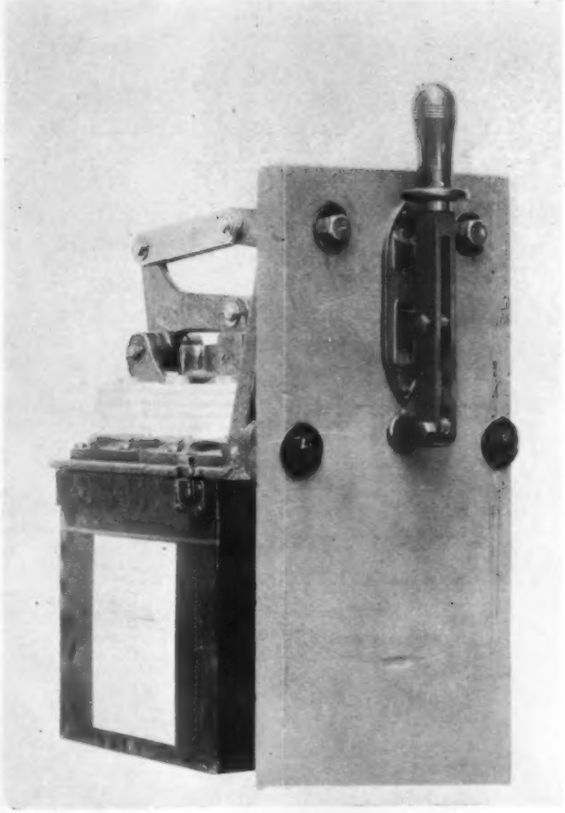


FIG. 2.—THE "OK" OIL BREAK HAND SWITCH—FRONT VIEW.

*Submitted for discussion at the Fifth Annual Convention of the Pacific Coast Electric Transmission Association, San Jose, June 18-19, 1901.

as above, or they may be mounted in fireproof brick compartments and operated at a distance.

This latter method of mounting is advised by the General Electric Company, which also recommends that

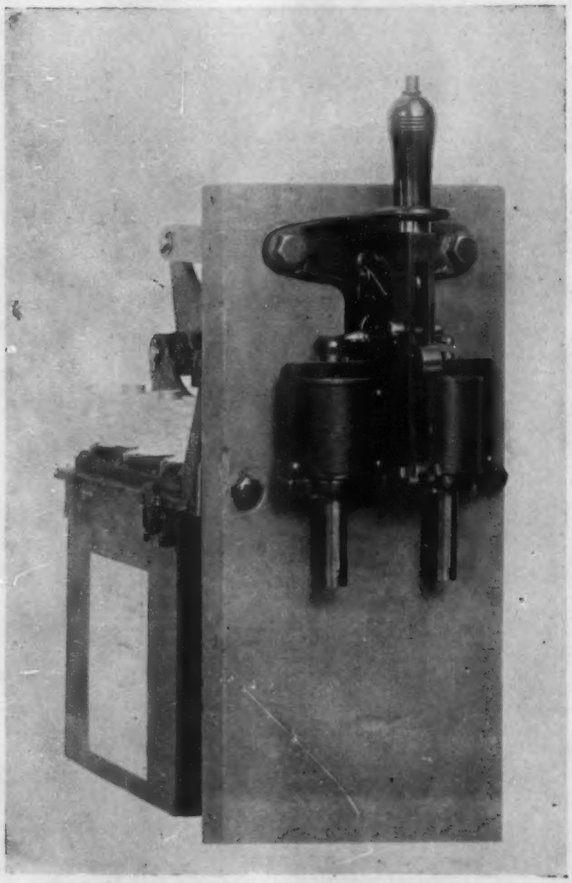


FIG. 3.—THE "OK" OIL BREAK SWITCH ELECTRICALLY OPENED, CLOSED BY HAND.

single-pole switches be used, each switch being mounted in a separate compartment. With this construction, it is practically impossible for a short circuit to occur between the different poles of the switch, and even should an arc be maintained, the fireproof construction of the vault would prevent the arc from spreading.

For large generating stations the form "H" oil switch is recommended (Figure 5). This switch is made with two cylindrical elements in one fireproof compartment and forming a double-break single-pole switch. For a three-pole switch, there are three compartments as shown. The two elements in each compartment are insulated from each other by large porcelain insulators. The connection between the two elements of a single-pole switch is made by a "U" shaped rod of copper, as shown.

The triple-pole switch is operated either pneumatically (the type used in the Metropolitan Street Railway Company's power-house, New York City), or electrically by means of a motor. This latter arrangement is to be used in the new station of the Manhattan Elevated Railway Company, New York City, and in the new power station of the Niagara Falls Power Company, Niagara Falls, N. Y.

In all of these latter stations the controlling of the oil switches is done from a small controlling board, by means of which one man can synchronize, throw in or shut down any generator by simply opening or closing a small switch on the board. In addition to the hand control, every switch can be supplied with an automatic attachment to open on an overload, either instantaneously or by a time limit, as may be desired; also by reversal of power in the line (instantaneous or time limit) or any combination of the above. For the automatic overload opening, series transformers are placed in the line and the secondaries of these transformers are connected to overload relays which operate the tripping circuit. If reverse current attachments are required, potential transformers must be used in addition to the current transformers.

An expulsion type of circuit breaker (type EA) has also been developed. Figures 6 and 7 show the front and back view of a 22,000-volt switchboard equipped with this circuit breaker, which is made in the following capacities:

One hundred ampere at 2500 volt, 300 ampere at 6600 volt and 50 ampere at 22,000 volt. In this type of circuit breaker the arc is broken in the long tube shown in the upper part of Figure 7, and the shock of the falling

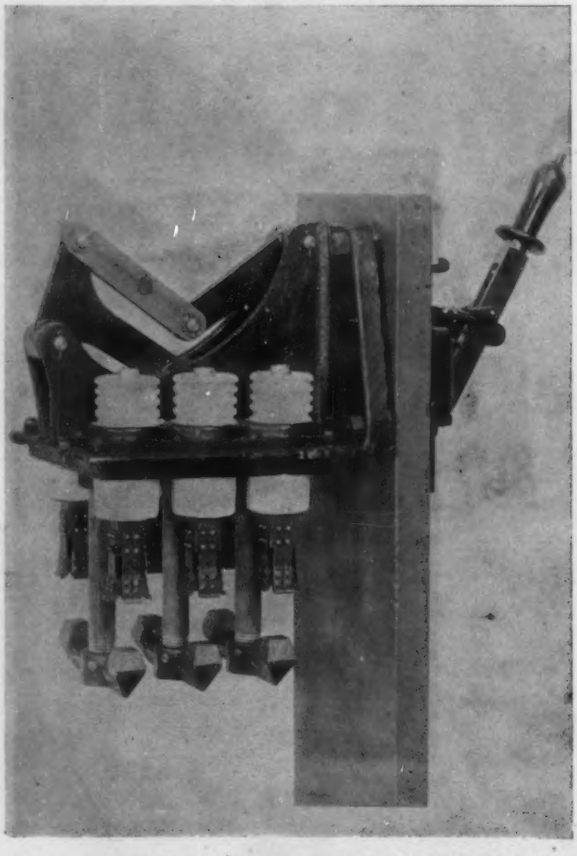


FIG. 4.—THE "OK" OIL BREAK SWITCH—ELECTRICALLY OPENED, CLOSED BY HAND.

"U"-shaped contact piece is taken up by the dashpots shown at the bottom of the board. The circuit breaker is closed by means of a rod which is pushed up through the bottom of the dashpot. This circuit breaker has proven to be most satisfactory. It owes its remarkable arc-extinguishing property to the combined explosive violence with which it opens and the great length to which the arc is drawn. It is automatically tripped the same as the oil switches and can be arranged to be operated by the time limit or reverse current attachments. In the design of all of the above apparatus, particular care has been taken to see that all conducting parts are

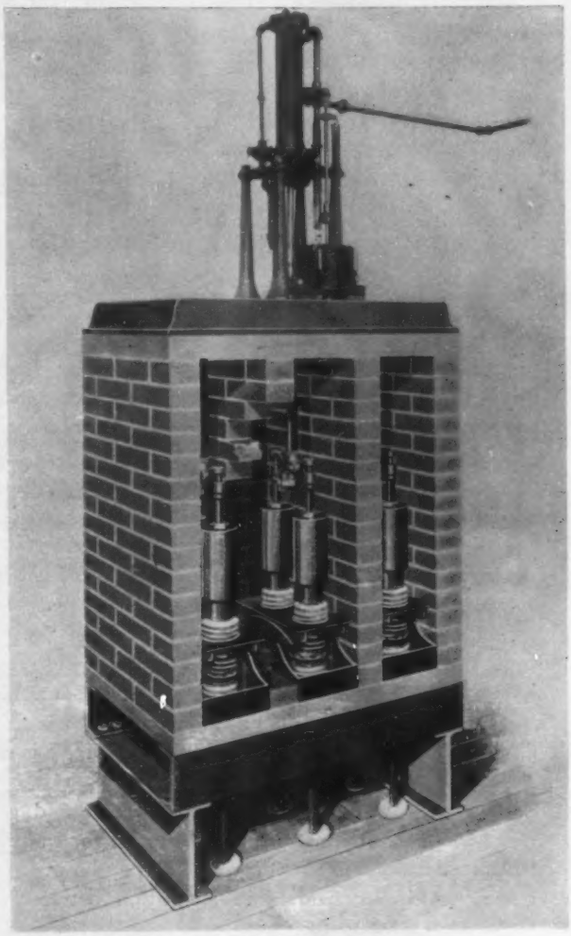


FIGURE 5.

thoroughly insulated and that all supporting parts are amply strong. For the insulation, the best quality of porcelain has been used, as both mechanically and electrically it is not excelled.

SWITCHING THAT'S BEWITCHING.

BY JOHN S. EASTWOOD.

The experience of the San Joaquin Electric Company in the operation of its 20,000-volt lines over a distance of sixty-five miles, leads us to believe that, in a matter of high-tension switching, the best place to break the circuit is at the battery switch on the relay of the water-wheel governor.

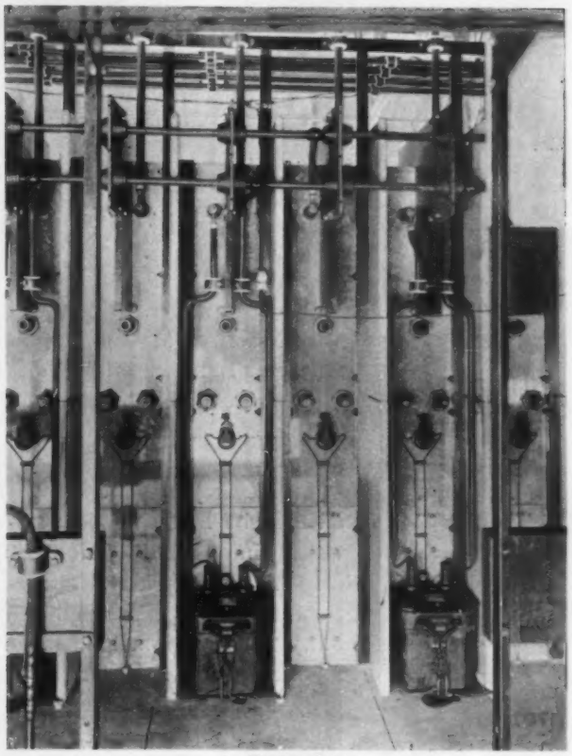


FIGURE 6.

Secrecy in telephoning is to be assured in Sweden by the use of an apparatus adopted by the authorities for indicating whether the telephone operator is listening to the conversation.

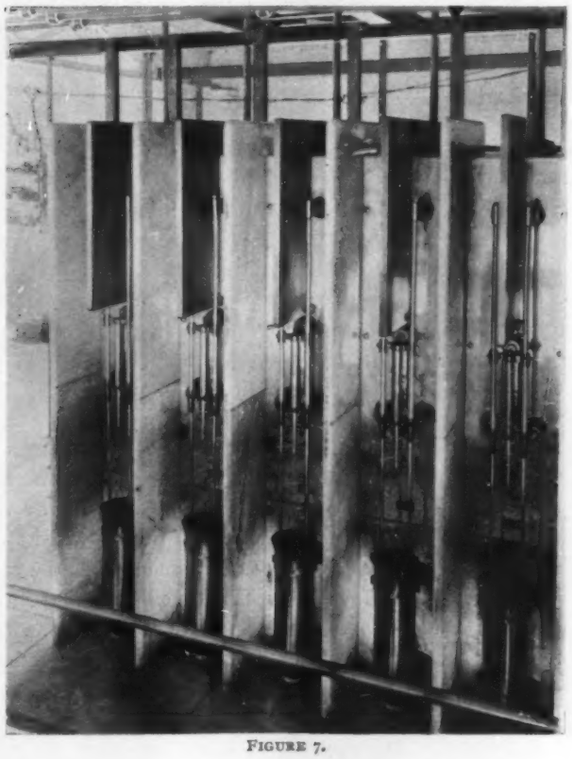


FIGURE 7.

15,000-VOLT SWITCHES PROVE RELIABLE.*

BY PHIL S. TAYLOR.

MY experience in high-tension switching has practically been limited to the work of the San Gabriel Electric Company and its allied interests. In the original installation of that company there were used high-tension switches of the plug panel type, which did not prove satisfactory for the hard and almost continuous work they had to do. Thereupon the writer, in conjunction with Mr. R. S. Masson, developed the switch known as the "M. T." fused switch, which was described in the San Gabriel edition of THE JOURNAL.†

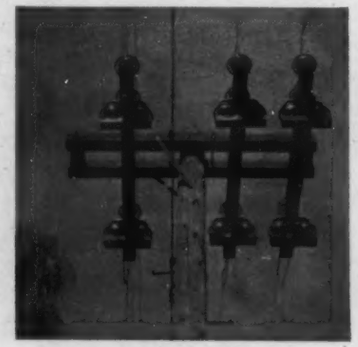
AN "M. T." POLE SWITCH.

In developing the "M. T." switch, the following points were taken into consideration: high insulation, simplicity, safety to the attendant operating and durability. The original installation for the San Gabriel Electric Company consisted of eighteen single-pole double-throw switches, which have been in daily use for nearly three years, and during the same period the San Gabriel Company has placed nearly 300 of this type of high-tension switch in service.

In considering the installation of a system of high-tension switches, the main feature to be taken into account is to give enough space between the switches, and the switches should be arranged to operate from the same floor on which the other regulating or controlling devices are situated. I believe the time is past when the control of the high-tension end of a transmission system should be placed in some out-of-the-way place, but, to the contrary, they should be in the most convenient and accessible place possible. In operating the San Gabriel Electric Company's plants we find that we use the 15,000-volt high tension switch end almost as much as we do the low tension side.

One of the interesting applications of the "M. T." switch by the San Gabriel Electric Company is shown in the accompanying illustrations, where the switch is installed in the main line to open it in case of trouble, permitting the company to run that portion of the line which is between the switch and the power-house. Figure 1 shows the switch as erected on a pole, and Figure 2 shows the switch open as well as a patrolman and the pole by means of which he operates the switch. There are several such line switches on the San Gabriel Company's high-tension lines, and they have always proved equal to any emergency.

At present the San Gabriel Company is using twenty sets of these switches on poles, and is adding more whenever it installs an outlying power substation. Plans are now being made for a new switching station to be located at Azusa, to handle twelve transmission lines that will emanate from that station. The high-tension equipment of this new station will contain above one hundred "M. T." switches.



THE "M. T." POLE SWITCH IN 23,000-VOLT SERVICE.

In conclusion, my experience sums itself up in this belief: Give high-tenson switches plenty of room—and use those of the "M. T." variety.

*Submitted for discussion at the Fifth Annual Convention of the Pacific Coast Electric Transmission Association, San Jose, Cal., June 18-19, 1901.

†THE JOURNAL, volume VI, November, 1898, page 81 *et seq.*

SOME EXPERIENCES IN HIGH TENSION SWITCHING.

BY ROBERT McF. DOBLE.

THE high-tension switches installed by the Mount Whitney Power Company are the familiar "M-T" fused pattern, with a 36-inch break and a separation between wires of 30 inches. The line potential so far has been 17,000 volts, but will be increased to 30,000 volts in the near future. The switches as installed were intended for 30,000-volt service.

The switches at the various substations are fused at such capacity as to protect the apparatus beyond the fuses, and in this service, owing to short circuit caused by the breaking down of the spark gaps on the line lightning arresters, the fuses have melted several times, sometimes to two adjacent ones going simultaneously with a fierce arc, but no damage resulted, as the length of break is sufficient to extinguish the arc.

These switches work satisfactorily in service and give no indications of proving other than suitable for the purpose; but it is extremely important that they be installed with a long break, a considerable separation between the line wires, and that no incoming or out-going line wires cross in proximity to where a severe arc might extend.

As there are conditions which may arise on a long distance transmission line which cause a very considerable increase in the potential beyond the normal, it is necessary to provide for the rupture of an abnormal arc, and in the type of switch, which depends upon the length of break for its action, safety can be assured only by giving plenty of room.

The high-tension switches installed by the Snoqualmie Falls Power Company are the "Westinghouse fused circuit breakers" with a 48-inch break, and have been successfully operated under severe conditions, at potentials upwards of 36,000 volts, with considerable lagging current, thus demonstrating the suitability of the switch for the

work. But this switch, like the other one referred to, requires a great deal of room, and is open to the objection of drawing a long severe arc, which is a menace to all wires in proximity.

From many observations of the operation, under varying conditions, of the long break open arc type of high tension switches, with their beautiful and startling pyrotechnical displays, requiring so much room for their installation as compared with the satisfactory and unostentatious operation of the enclosed oil-break types, occupying a minimum of space, I am clearly of the opinion that the high-tension switch of the future will be constructed along the enclosed type with the breaking contacts immersed in oil or some other insulating fluid.

The practice of switching high-potential transformers and lines with current on seems to be a bad one, and is fraught with danger to the apparatus involved, as abnormal strains are set up, which repeated, will eventually cause trouble.

Making or breaking a high-tension circuit, one wire at a time, as is usually done, with a long transmission line, causes an unbalancing, which is manifested by the heavy static discharges across the spark-gaps connected with the transformers, and often by discharges across the lightning arresters.

This manifestation is an indication of a severe abnormal condition, and should be heeded as a warning.

ANENT THE TELLURIDE 40,000-VOLT SWITCHES.*

BY M. G. CONVERSE.

ALL the work I have done in the line of high-tension switches has been as an engineer for the Telluride Power Company, hence I would prefer that information concerning these devices should come from the company named. I may say, however, that in 1897 I designed and built some switches for 40,000-volt work for the Telluride Power Company in the shops of the Wagner Electric Manufacturing Company at St. Louis, Mo. These switches were made to open simultaneously the three lines of the 40-000-volt three-phase circuit under full load. They were put in service at that time and have given satisfaction since. In operation, the arc is drawn out until it breaks of its own accord.

There is nothing particularly new or startling about these switches. They were the work of the Telluride Power Company rather than of the Wagner Company, as were also the transformers, switchboards, etc., for the same installation. This is a point that has been overlooked since that time by the Wagner Company.

I may add that since the above-mentioned switches were constructed, other switches have been built on the same lines, but with some improvements, by the Telluride Power Company at its shops in Utah.

[The switches referred to in Mr. Converse's contribution were described in THE JOURNAL for June, 1898 (Volume V, page 172). They are rigidly connected together so as to be operated by a common switch bar, and each switch gives a 6-foot break, the separation between the switches being 5 feet. Each switch carries for a load of 700 horsepower a single No. 30 B. & S. bare copper wire, 36-inches in length, and over which an asbestos tube is drawn.—The Editor.]

*Submitted for discussion at the Fifth Annual Convention of the Pacific Coast Electric Transmission Association, San Jose, Cal., June 18-19, 1901.

GAS POWER AND ELECTRICAL DISTRIBUTION.*

ONE of the most interesting features in the development of the Great Pilares Copper Mine, at Nacosari, in Sonora, Mexico, is the successful use of a gas-power plant with electrical distribution, using for fuel wood or local bituminous coal. The mine is operated by the Moctezuma Copper Company, controlled by Phelps, Dodge & Company, of New York. Dr. James Douglas, president, Professor A. H. Ricketts, geologist and metallurgist, and Mr. John Langton, mechanical and electrical engineer, selected the type of plant to be used, and Mr. Langton had charge of the installation and operation of the gas plant, the gas engines and electrical apparatus. A notable point in this plant is that all the power is generated at a central station.

The gas plant consists of two sets of Loomis generators, each set having two 5 by 15 feet generators, with waste-heat boiler, scrubber, exhauster, valves, etc. The generators are cylindrical, constructed of steel, 9 feet in diameter and 15 feet high. The lining is of firebrick, with arched grates, ash-pit and flue to boiler in the bottom. The vertical boiler is of the multitubular type. All of the gas generated passes through this boiler, thus utilizing the sensible heat in the gas for steam making. The steam from this boiler is passed through the fires for decomposition. The exhauster is of the Roots type, and by altering its speed, the rate of gas making can be changed to meet varying demands for power. Each set of generators will produce gas enough to supply 1000 brake horsepower of gas engines, one being in continuous service, with the other set in reserve, thus insuring continuous operation.

Two qualities of gas are made alternately, as the fires are supplied with steam or air, so two gas-holders are in use, one having a capacity of 5000 cubic feet, for water gas, and the other a capacity of 15,000 cubic feet, for producer gas. The two gases are mixed in fixed proportion, giving a uniform gas, which is essential in operating gas engines.

With the Loomis system the fuel is charged through an open door in the top of the generator and the gas is exhausted from the bottom of the fire, thus converting all tarry and volatile matter in bituminous coal and wood into a fixed gas, which is then drawn through an ordinary water spray scrubber by the exhauster and delivered to the holder. Coal is shoveled into the top doors as needed. Wood is thrown in in lengths of two or three feet and ordinary cordwood diameters. The fires are cleaned but twice a week. The water for the scrubber is cooled by a simple tower and used over and over.

Electric motors are used to drive the several departments of the reduction plant. The power house is a steel structure 108 by 62 feet. The steel framework supports a 12-ton traveling crane with a span of 25 feet, available in any part of the building. The dynamos are operated by eight Crossley gas engines, made in Manchested, England, rated at 110 horsepower at 200 revolutions per minute. Each engine with fly-wheel weighs 40,000 lbs. They are the four-cycle, hit-and-miss type. Additional engines rated at 400 horsepower more are to be installed. Eight tanks contain water for the circulating system for cooling cylinders. Each engine is belted direct to a 65-kilowatt 260-volt shunt-wound direct-current General Electric generator with a normal speed of 910 revolutions per minute. The reason shunt-wound instead of compound-wound machines were selected is to insure protection against any lapses of the engines. If any of these should drop its

*The *Engineering and Mining Journal*, p. 591, May 11, 1901.

speed below normal, the affected dynamo for the time being would become a motor and would not, therefore, interfere with the action of other motors. The current from the eight generators is carried to a switchboard by overhead cables. This switchboard consists of eight generator panels, one main station panel and one feeder panel. The current is transmitted to the departments over four circuits of Standard conductor, each having an area of 500,000 circular mills. Two of the circuits are taken to two distributing boards in the concentrator, one for each mill, giving a total of 500 horsepower with an overload capacity of 25 per cent. Another is taken to the furnace and converter blower room for other machinery and lighting. Any dynamo can be cut off from the switchboard from three different points in the power-house—at the switchboard (at quick-break switch), at either dynamo, and at either engine by a push button that operates as a solenoid on the circuit breaker. The lighting equipment at the beginning for the mill and the town consists of 400-candlepower 250-volt incandescent lamps and 10 arc lamps, constant potential. A telephone service will connect all departments.

Where fuel is high and water supply is limited or unfit for boiler use, the saving with gas power plants is very large, the principal economy being in fuel. A plant like the above consumes from 1 pound to 2½ pounds per brake horsepower hour of bituminous or anthracite coal, varying with the quality of coal. The consumption at Nacosari, using bituminous coal from New Mexico, is less than 1½ pounds per brake horsepower, and using wood, about 3 pounds wood for the same unit. This is less than one-half the fuel consumption in the best large steam plants on similar work and one-quarter the fuel consumption of the ordinary plant. Where low-grade ores are worked and much power is required the power question becomes an important factor.

The advisability of using electrical distribution depends upon local conditions. In some cases it certainly gives most excellent results, and where many changes are to be made in the processes, and power required in different parts of the work varies from time to time requirements are easily and quickly met. In places where power is required at inaccessible places, the central plant can be placed near the wood or coal supply and the power distributed electrically at less cost than transportation of fuel.

Obituary

ALBERT P. BRAYTON, JR., Vice-President and Manager of the Pelton Water Wheel Co., died at the family residence, No. 1167 Jackson street, Oakland, on the evening of Sunday, May 12th, from pneumonia, after a very brief illness. Mr. Brayton contracted a severe cold the first part of the week, but continued at his desk at the office until Tuesday evening. During the night a fever set in and Dr. A. Liliencrantz was summoned; pneumonia developed and Dr. P. L. Wheeler was called into consultation. The patient grew steadily worse until Sunday night at 7:40 o'clock, when death came.

Not only in club, society and lodge circles, but also in the business world, Mr. Brayton has long been a prominent figure. He was thirty-four years of age, and had hosts of friends to whom his untimely death came as a great shock. To know him was to love him; a friend once he was always a friend, loyal and true, manly and generous in all his associations to an unusual degree, and gifted with a personal magnetism that attracted and held the interest of all.

To him is largely attributed the development and wide reputation gained by the Pelton water wheel, which, until a few years ago, was scarcely known outside of California. Mr. Brayton, with his father and brother, purchased the original patents and formed the Pelton Water Wheel Company in 1888, which, since its inception under his personal supervision, has developed the then-crude mining wheel to a highly efficient prime mover, to be found in every town and camp where pressure can be developed and power can be used.

The deceased was of an old and most highly respected family. His uncle, Dr. Isaac Brayton, was for years President of the California College, which formed the nucleus for the present State University; while his father was for years associated in the ownership of the Pacific Iron Works, which furnished much of the mining machinery on the Pacific Coast during the early mining days. As a result of early environment he developed a taste for mechanical pursuits which was nurtured by indulgent parents, and while still young he entered his father's shops, serving his time as an apprentice; travel later broadened his mind, and, with early training, eminently fitted him for the arduous duties connected with placing on the market a new invention that has since so thoroughly identified him with the mechanical trades.

Mr. Brayton was an active member of the Bohemian Club of San Francisco, and the Athenian Club of Oakland, of which he was at one time the president. To every friend and acquaintance his death came as a saddening influence and awoke in all a most heartfelt sympathy for the bereaved relatives.

Telephony

THE REACTANCE OF HIGH-TENSION TRANSFORMERS.

AN interesting instance of the application of the telephonically termed "McCarthy bridging system"* was noted during the brief experimental work which preceded the commercial delivery of power into Oakland, Cal., over the 142-mile line of the Bay Counties Power Company in April. The power circuits were ready for testing before the telephone lines were completed, and this condition made it necessary to utilize the power lines for telephoning between the power house at Colgate, in Yuba County, and Oakland in the intervals between the high potential tests.

At first the raising and lowering transformers of the entire system were cut off from the two line wires that were to be used telephonically, when the telephones would be connected and the conversation would ensue. Then, as the conversation ended, the 'phones would be cut out, the transformers would be cut back into service again, and the tests would be proceeded with according to schedule.

Such changes as these had been made several times before it occurred to the engineer in charge at the Oakland sub-station that the self-induction of the high-tension side (40,000 volts) of the transformers should be ample to prevent the short circuiting of the line when used in telephoning. The next time there was telephoning to be done the transformers were left in circuit and the telephoning was accomplished with the same facility as though it was over an exclusive line.

A few days afterward the telephone lines were completed through from Colgate to Oakland, and telephoning over power lines in multiple with 750-kilowatt transformers was no longer a necessary expedient.

Personal

O. H. ENSIGN, engineer of the Edison Electric Company, Los Angeles, has been promoted to the position of superintendent and engineer of the same company, thus filling the duties which formerly devolved upon himself as engineer, and H. G. Thaxter, who has recently resigned the superintendency of the company that he might become identified with the new paper insulating conduit company recently organized in Los Angeles.

Insurance Engineering, a most meritorious magazine devoted to the engineering features of the science of diminishing hazards to property and life, made its appearance in April. It is published by The Insurance Press, 120 Liberty street, New York.

*See Miller's "American Telephone Practice," third edition, page 297, *et seq.*